Iron and Steel ENGINEER

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SEPTEMBER, 1957

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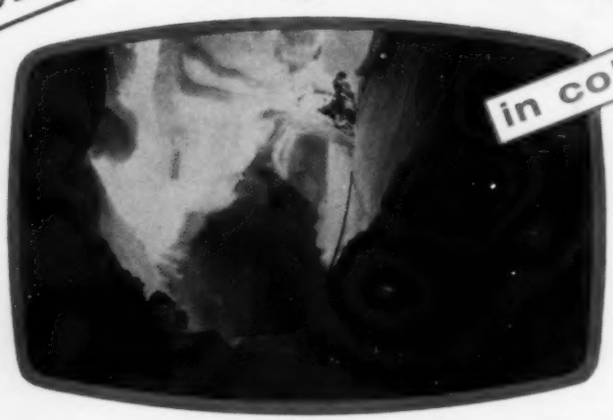
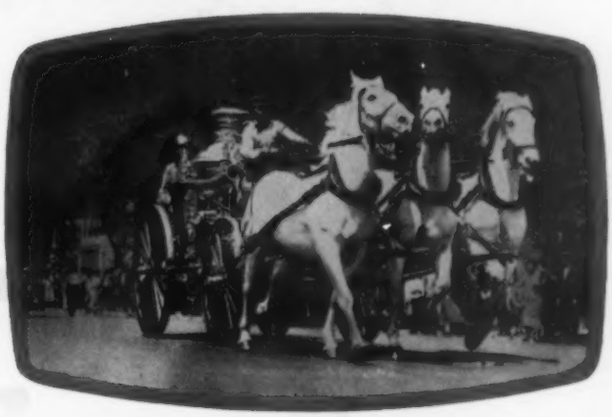
Two big hour-long spectaculars this fall





Over 126 NBC STATIONS, SEPTEMBER 23rd

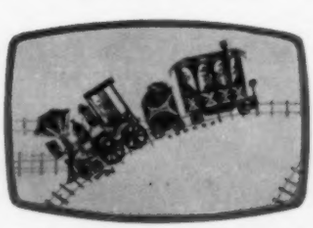
"Eleven Against the Ice". See men and machines build a "turnpike" across Antarctica's frozen wastes—in spite of 200 mph winds and temperatures of −120°. It's a triumph of engineering and human courage, a whale of a TV show.

Over 142 NBC STATIONS, NOVEMBER 21st

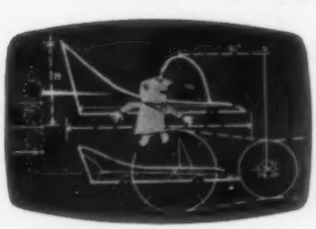
"The Innocent Years". Exciting old films and newsreels recapture the drama of "Teddy" Roosevelt, Thomas Edison and Mark Twain in action. Enjoy the fun of family picnics, the joys of people in the last untroubled time in our history.

And commercials that help you sell . . .

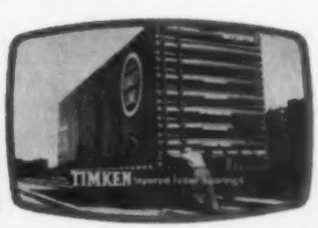
See How man stumbled on the concept of the wheel.



See Why America's railroads have always led the world.

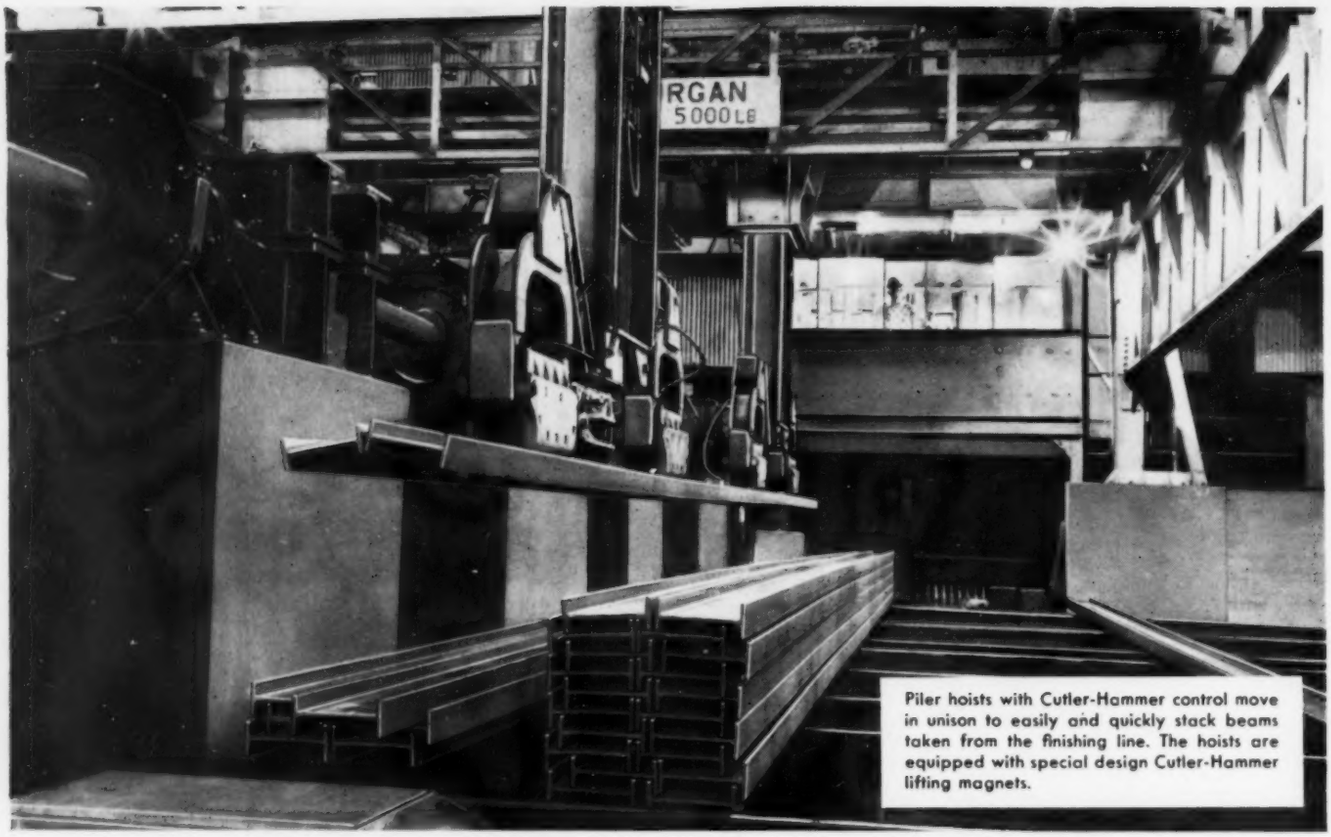


See Why Americans jump for the latest thing in cars.



See One man push a freight car all by himself.

Years of national and trade advertising, backed by their superior performance, have made "Timken" the best-known name in bearings—a name that helps to sell the products that use Timken® bearings. Now, network television will build an even greater awareness of Timken bearings—make them an even bigger sales plus in the equipment you sell. The Timken Roller Bearing Company, Canton 6, Ohio. Cable: "TIMROSCO".



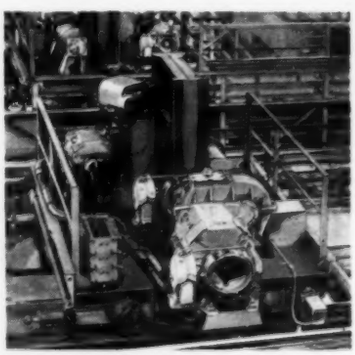
Piler hoists with Cutler-Hammer control move in unison to easily and quickly stack beams taken from the finishing line. The hoists are equipped with special design Cutler-Hammer lifting magnets.

Cutler-Hammer Control and Magnets team to cut beam handling costs

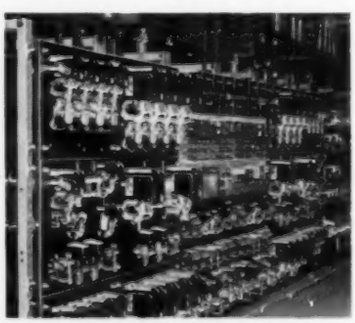
Classifying and stacking finished beams to fill customer orders has always been a production bottleneck involving both back-breaking manual handling and the frequent use of an overhead crane withdrawn from its normal service. But now at U. S. Steel's South Works, the job is done quickly and safely by special beam piling cranes equipped with Cutler-Hammer D-c magnetic crane control and special Cutler-Hammer bi-polar lifting magnets. The heart of this beam handling system is the unique controller which automatically positions the hoist trolleys accurately on adjacent piler crane bridges. With this modern electrical equipment, which includes a Cutler-Hammer designed magnetic amplifier type position regulator, the piler hoist operator simply and easily selects beams as specified from the end of the finishing line and stacks them according to the orders in hand.

This is another typical example of mill engineers and Cutler-Hammer engineers working together to solve mill problems. Another instance among many at the great USS South Works where Cutler-Hammer equipment serves faithfully from the giant ore unloaders at the start of mill operations to the unique piler hoists at the very end of the finishing line. You too will find it pays to work with Cutler-Hammer to gain new efficiency and new savings with time-honored Cutler-Hammer dependability.

CUTLER-HAMMER, Inc., 1269 St. Paul Avenue, Milwaukee 1, Wisconsin.
Associate: Canadian Cutler-Hammer, Ltd., Toronto.



Overhead view of beam piling hoists showing Cutler-Hammer brakes and limit switches used.



Cutler-Hammer control panel for unique piler hoists at USS South Works.

CUTLER-HAMMER
MOTOR CONTROL
C-H

LOOK TO CUTLER-HAMMER MILL EXPERIENCE . . . AS BROAD AS IT IS LONG

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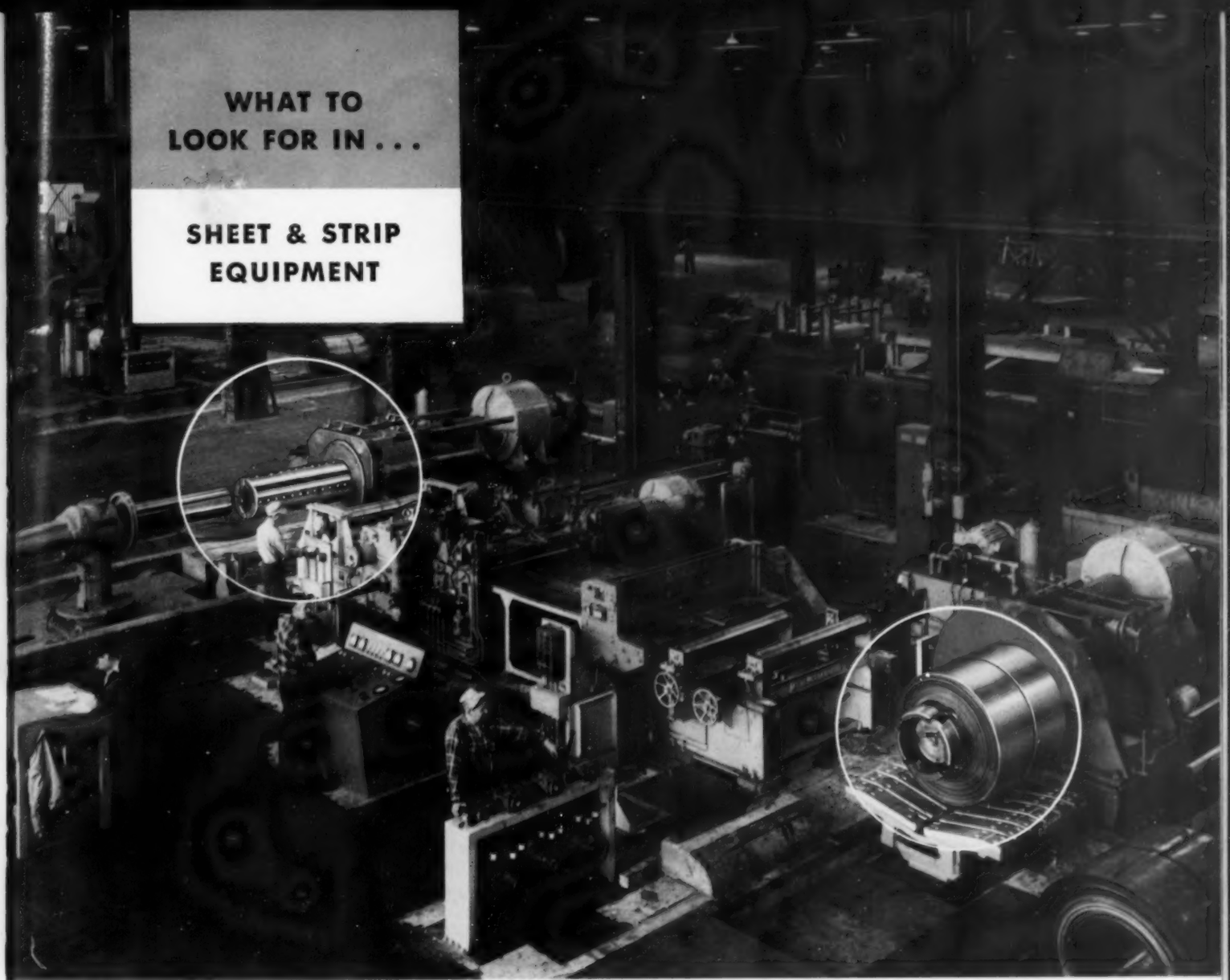

there's a DIFFERENCE IN REELS

Balanced Drum Segments, interlocked and chrome plated to prevent scoring of drum.

Shafts mounted in anti-friction bearings with ample thrust and radial load capacity.

Hydraulic traversing and elevating coil carriage.

Coil Stripping Device (Tension Reel) prevents telescoping of coil.

OPERATOR EASE: Adequate drum expansion permits loading or unloading coils easily Hydraulically operated strip aligner permits 6" movement either side of center line of line. Automatic Gripper Bar on Tension Reel grips strip from minimum to maximum without adjusting. Suitable for either over or underwinding of strip. On Payoff Reel, patented coil centering by adjustable stop plate supported by two round steel racks . . . easily adjusted with handwheel. Indicator gives operator a clear view of strip width.

EASY MAINTENANCE: Oil Seals of special split design for drive housing; circulating oil system for drive with separate motor drive. Balance of unit easily serviced by accessible fittings or centralized lubrication system.

GOOD DESIGN: 4-segment Drum provides more contact with coil I.D. The Tension Reel starts winding any coil in an almost perfect circle. Aetna's design of reels puts minimum unit pressure on sliding shoes when full weight of coil is on the drum.

RUGGEDNESS: Helical Gear Drive—quiet and smooth, strong, less weight; heavy structural steel weldment with machined ways provides a rugged strong base for high speeds without vibration

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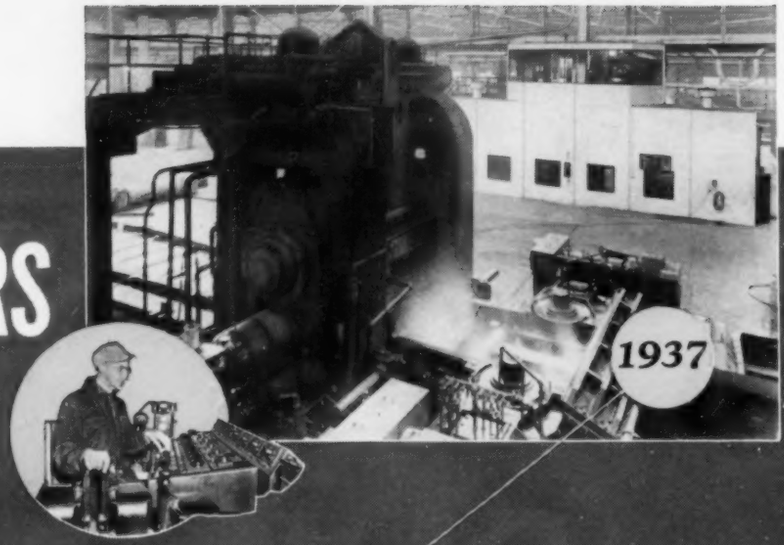
THE AETNA-STANDARD ENGINEERING COMPANY

GENERAL OFFICES: PITTSBURGH, PA. **PLANTS: ELLWOOD CITY, PA., WARREN, OHIO**

CONTINUOUS GALVANIZING LINES • CONTINUOUS ELECTROLYTIC TINNING LINES • SIDE TRIMMING AND SHEAR LINES AND OTHER FINISHING EQUIPMENT • CONTINUOUS BUTT WELD PIPE MILLS • SEAMLESS TUBE MILLS • DRAWBENCHES AND OTHER COLD DRAW EQUIPMENT • ROLLS AND CASTINGS • EXTRUDERS, MILLS, PRESSES FOR RUBBER AND PLASTIC

20 YEARS OF EC&M DESIGN LEADERSHIP!

IN AUTOMATIC-POSITIONING SCREWDOWN CONTROL



20 YEARS AGO, EC&M Automatic-Positioning Screwdown Control was installed in this mill. It has been doing an outstanding job ever since.

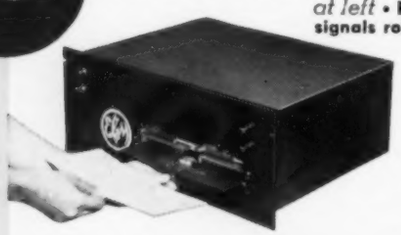
Since then, this same basic EC&M system has been installed in nearly 50 other mills—including blooming mills, billet mills, beam mills, plate mills and reversing roughers ahead of hot strip mills.

Now, this same proven system has been expanded to provide programming either by punched cards or by slider panels—for new or existing installations, operated from either constant or adjustable voltage.

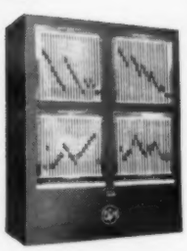
1957

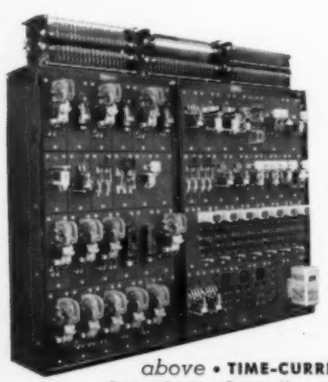
PROGRAMMING NOW AVAILABLE BY PUNCHED CARDS OR SLIDER PANELS

at left • **Punched Card Reader automatically signals roll setting for each pass**



at right • **Slider Panel provides roll settings for 2 complete schedules. Pistol grip switch provides immediate transfer from one to the other**





above • **TIME-CURRENT Screwdown Controller with Magnetic Amplifier Control and Relay Panel**

EC&M DESIGN ADVANTAGES

- A single pushbutton controls the most important operation in rolling. Screwdown rolls accurately set for each pass. No schedule to remember.
- Ability to change from automatic to manual and back again, instantly available to the roller.
- EC&M system is direct reading. No coding and de-coding requiring multiplicity of relays.
- Easily serviced by regular maintenance crew. Simple adjustment for roll changes.
- Over 900 roll positions obtainable from only 2 small (main and vernier) face-plate, positioning switches.
- New operators quickly trained.

They all add up to GREATER TONNAGE— ACCURACY— QUALITY

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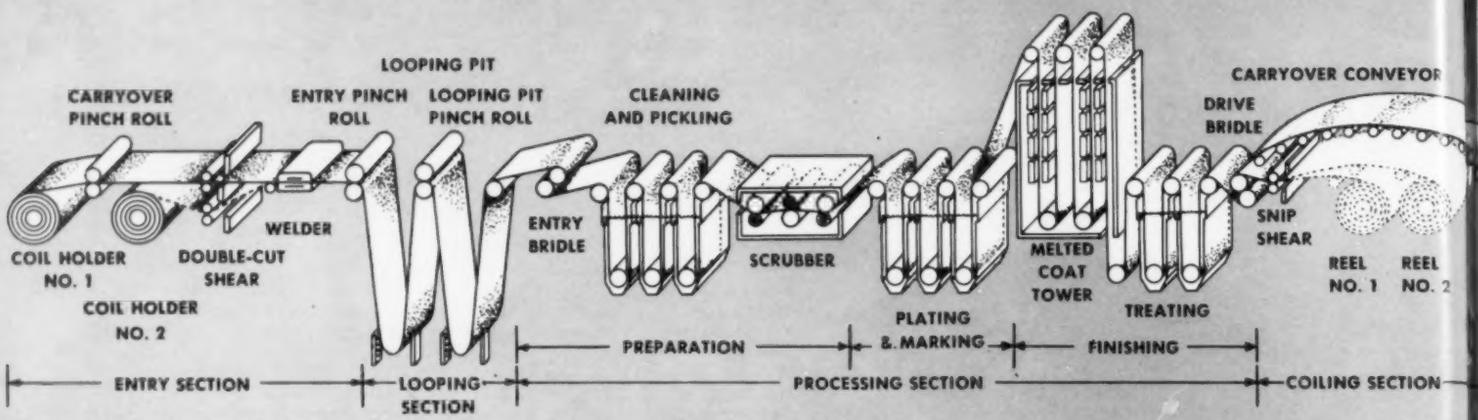
Over 80% of all FERROSTAN* TINNING LINES are CLARK



ENTRY SECTION. This section operates as an independent unit so it can be started and stopped while the rest of the line is running. Entire section can be accelerated to overspeed condition to replenish the loops. When loops are filled, speed is automatically reduced to match that of processing section.

LOOPING SECTION. Loops provide storage for strip during periods when entry section is stopped for coil changes, permitting processing section to run continuously. Multiple loops permit shallower looping pit, and can be synchronized to stay uniform. Modulated loop control provides stepless regulation of entry speed so strip is fed to processing section at constant speed.

PROCESSING SECTION. Plating, marking, melted coat and chemical treatment currents are accurately synchronized with line speed. Adjustable differential plating control can be provided to permit heavier tin plate deposit on one side of strip. Necessary torque and speed regulation is provided for individual motor drives on conductor, sink and deflector rolls. Overall line speed is accurately regulated by means of magnetic amplifiers.

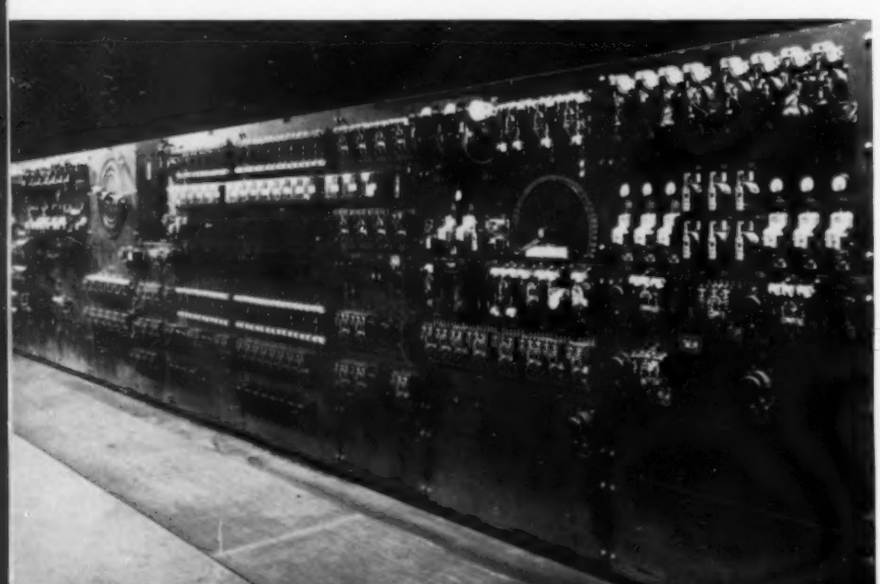
COILING SECTION. Line shown permits optional type operation, either coiling or shearing. When coiling, control transfers from one reel to the other while line is running. Carryover conveyor is used only when shearing.

Continuous electrolytic tinning lines represent just about the most complicated electrical control problems to be found in any manufacturing process. From coil holders at entry end to recoilers—or classifier and piler—at exit end, line speeds and tension must be precisely regulated and coordinated with processing operations. Only with the most carefully engineered control system can the line be operated continuously at high speeds to produce the high uniform quality tinned strip demanded by the canning industry —No. 1 consumer of tin plate.

The Clark Controller Company, with its more than 30 years experience in specialized engineered control, and with electrical control its sole interest, is the leader in supplying the elaborate and complicated controls required by Ferrostan* tinning lines.

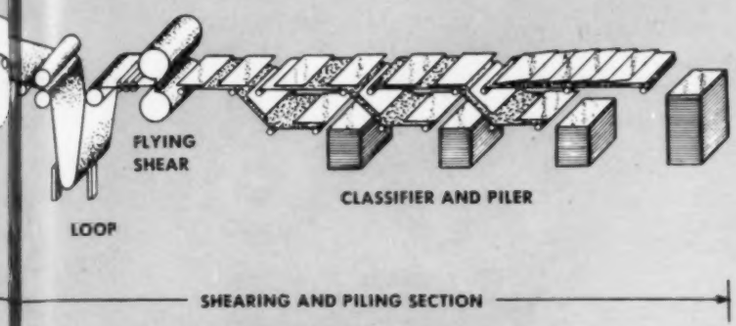
Shown above is a flow diagram of a typical Ferrostan* line, indicating the essential components and the complexity of the control required. This line provides both shearing and piling of tinned strip, and coiling. A number of lines, originally designed for only shearing and piling have recently added coiling—with Clark engineering the supplementary control.

Photo Courtesy The Wean Engineering Company, Inc.



A portion of the main control panel for a Ferrostan* tinning line . . . In addition to tinning lines, Clark is a major supplier of essential control for all types of processing lines in the basic metal industries including rolling mills, pickling, slitting, shearing, annealing and galvanizing lines, as well as control for wire drawing, blast furnace charging, cranes and many other mill and material handling operations.

ELECTROLYTIC CONTROLLED



SHEARING AND PILING SECTION. Modulated loop control provides stepless speed regulation to permit accurate shearing. Sheets are scanned by various detection devices and piled accordingly to classification. Speed of sheets coming from shear is regulated to avoid damage and permit uniform piling.

Typical Ferrostan* electrolytic tinning line—completely equipped with Clark engineered control. Entry section in foreground shows coil holder, shear and welder. Looping pit is below floor level and not visible. Preparation and plating sections can be seen in front of melted-coat tower in upper right. Classifier and piler are in far background.

*Trade Mark - U. S. Steel Corp.

CLARK-CONTROLLED FERROSTAN* AND FERROSTAN* TYPE ELECTROLYTIC TINNING LINES

Installation	Year put in Operation	No. Lines
Gary Sheet & Tin Mill	1937	1
Gary Sheet & Tin Mill	1942	3
Irvin Works	1942	3
Tennessee CI & RR Co.	1942	2
Wheeling Steel Corp.	1942	1
Columbia Steel	1947	1
Richard, Thomas & Baldwins (G.B.)	1947	1
Steel Company of Canada	1948	1
Gary Sheet & Tin Mill	1951	1
Wheeling Steel Corp.	1951	1
Ferblatil (Belgium)	1951	1
Columbia Steel	1952	1
Fairless Works	1952	1
Steel Company of Wales (G.B.)	1952	2
National Steel Co. of Brazil	1953	1
Tennessee CI & RR Co.	1955	1
Toyo Kohan (Japan)	1955	1
Yawata (Japan)	1957	1
Altos Hornos de Mexico	1957	1
Cornigliano (Italy)	1957	1
Fuji (Japan)	*	1
Yawata (Japan)	*	1
Kaiser Steel Corp.	*	1
* Under Construction	TOTAL	29

The **CLARK** **CONTROLLER** *Company*

Everything Under Control

1146 East 152nd Street • • Cleveland 10, Ohio

Here's annealing experience that dominates the industry

When it comes to single stack annealing furnace experience, there's really only one qualified engineering firm — that, the Lee Wilson Engineering Company, Inc., who have just received an order that will put them over the 500 furnace mark — more than 10 times the number of single stack furnaces built by the rest of the industry combined.

Lee Wilson first developed the single stack — high convection furnace some 10 years ago. Convinced that the Single Stack method was far superior to the multiple stack, Lee Wilson went to the design of single stacks exclusively in 1952, and is still the only exclusive builder of this type furnace.

TREND TO SINGLE STACK GROWS

In the past four years the industry has come to recognize the tremendous benefits of the single stack for volume annealing and, as a result, Lee Wilson has supplied furnaces to practically every major steel producer in the United States and abroad. A definite trend finds several of the large producers abandoning multiple stack annealing entirely.

Lee Wilson has designed and manufactured more than 10 TIMES AS MANY single stack furnaces and bases as the rest of the industry combined!

Get all the facts before you decide what kind of annealing system is best for your operation and we know you'll specify Single Stacks by Lee Wilson.

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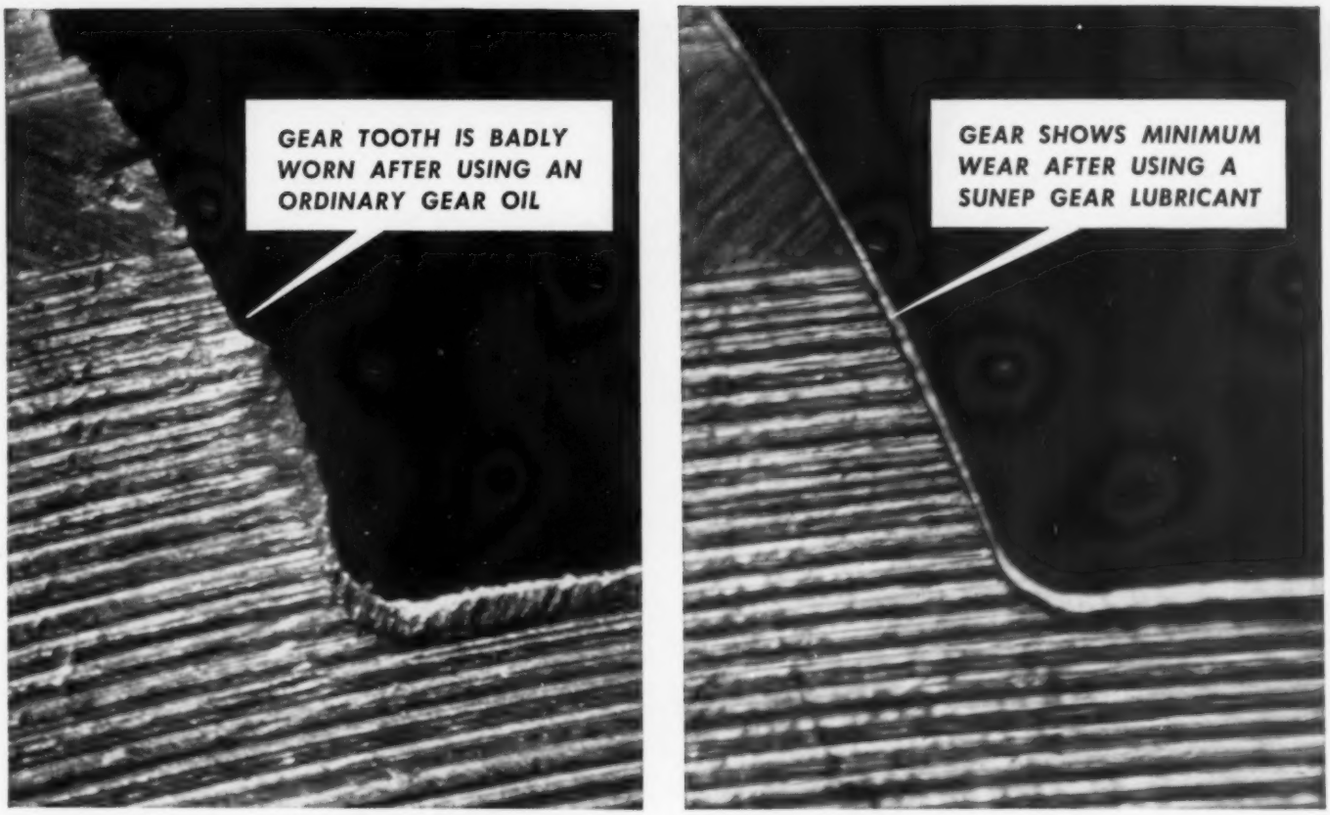
MAKE THE BEST METALS BETTER

* ORIGINATORS AND LEADING PRODUCERS OF SINGLE-STACK RADIANT TUBE FURNACES



COMPARATIVE TESTS on identical new worm gears demonstrate superiority of Sunep Gear Lubricant. Gear on left, using a compounded cylinder oil, shows excessive wear at 70 hours. Gear on right, protected by Sunep, shows minimum wear after running over 200 hours!

HERE'S PROOF SUNEP GEAR LUBRICANTS MINIMIZE WEAR

Sunep Gear Lubricants cut power losses...protect against overloads ...lengthen gear life...reduce maintenance costs and replacements.

During recent tests gear units protected by Sunep Gear Lubricant showed an absolute minimum of wear when run at normal rated capacity. There was no indication of scoring or wear even when run at overloads up to 118%! Power consumption was reduced up to 25%. Damage from shock loads was nil.

In addition to outstanding load-carrying ability, Sunep Gear Lubricants are extremely stable, non-corrosive, prevent rusting, keep gears and bearings clean.

For complete information about how Sunep Gear Lubricants can help give longer life to your worm gear units, see your Sun representative...or write SUN OIL COMPANY, Philadelphia 3, Pa., Dept. IS-9.

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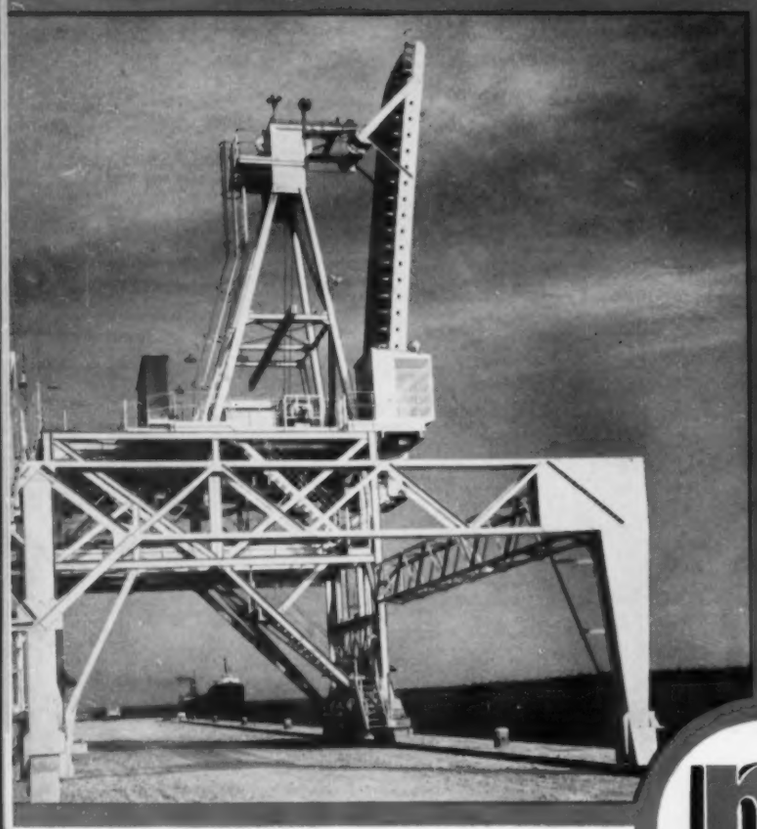
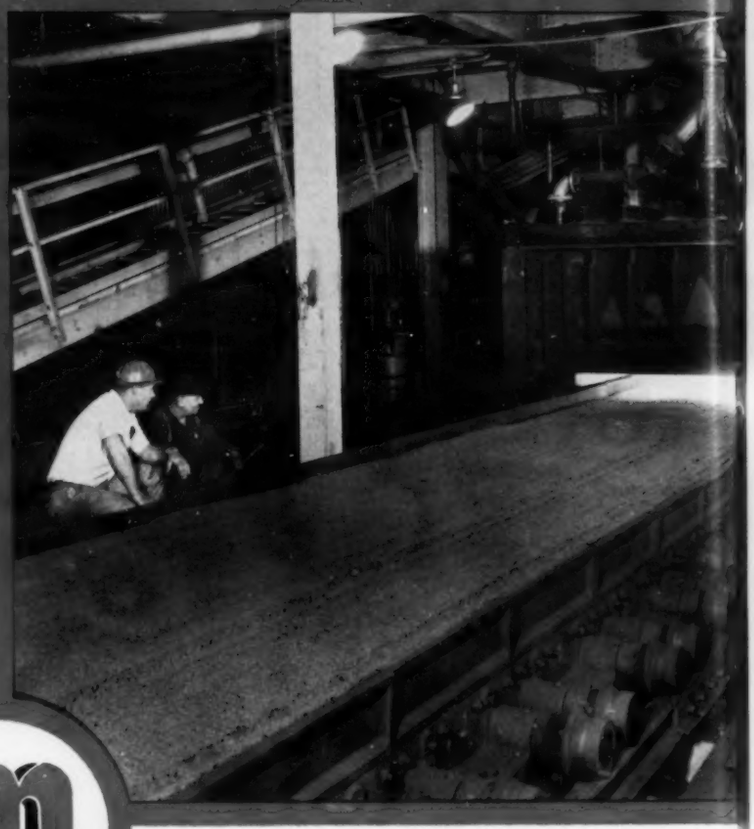
IN CANADA: SUN OIL COMPANY, LTD., TORONTO AND MONTREAL

from MINE to MILL through FINISHED PRODUCT



McDowell shiploader at Presque Isle, Michigan stone plant



Dwight-Lloyd® sintering plant at Benson Mines, N.Y.

THE McDOWELL METHOD *is a complete engineering and construction service for basic industries*

THE McDOWELL FAMILY OF RELATED ENTERPRISES

McDOWELL COMPANY, INC.
Cleveland, Ohio

Engineers and constructors of complete mechanical plants for basic industries, embracing engineering design, manufacture of equipment and turnkey installation of going plants, delivered in operation. Fixed and movable bridges.

DWIGHT-LLOYD DIVISION
Cleveland, Ohio

Engineers and constructors of ore beneficiating, sintering, cement producing, lightweight aggregate, etc. plants. Operates Dwight-Lloyd Research Laboratory of complete minerals processes.

RIVERSIDE DIVISION
Martins Ferry, Ohio

Steel fabricating plant serving McDowell divisions.

ABCs SCALE DIVISION
Cleveland, Ohio

Integrating scales for conveyor belt weighing, totalizing

THE WELLMAN ENGINEERING CO.
Cleveland, Ohio

Engineers and manufacturers of bulk materials handling systems, heavy hoisting equipment, steelmaking machinery, and industrial gas producers.

ANKER-HOLTH DIVISION
Port Huron, Michigan

Manufacturers of all types of power cylinders.

LOCOMOTIVE CRANE DIVISION
Cleveland, Ohio

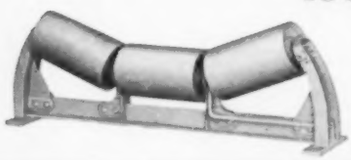
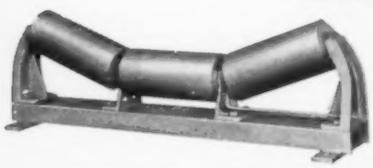
Successor to Browning Locomotive Cranes.

WILLIAMS BUCKET DIVISION
Akron, Ohio

Complete range of contractors' sizes of clamshell and dragline buckets; Wellman-built engineered overhead bridge buckets.

MATCH IDLERS TO THE JOB

...LINK-BELT can meet your specific load and capacity requirements

IDLER SERIES	TYPE OF IDLER DUTY	TYPICAL APPLICATIONS
NEW 50	General duty conveyor • for maximum loads of 100 lbs. per cubic foot • for moderate lump sizes	Designed for conveyors carrying medium loads or for installations requiring intermittent operation.
100 	"Round-the-clock work horse" • handles all but the heaviest and coarsest materials	Coal, coke, sand, gravel, iron ores, sinter, taconite, potash.
200 	Rugged heavyweight • for continuous service • carries the heaviest and coarsest materials	Heavy ores, such as iron, copper, etc. . . . on conveyors employing high-capacity belts.

LINK-BELT SERIES 100 IDLERS on this 42-in. wide, 218-ft. long belt conveyor carry 800 tph of ore from primary screens to stock pile.

TO TRAIN YOUR BELTS for proper operation . . .

BELT TRAINING IDLERS Left, positive action type trains and protects single direction belts. Actuating disc type at right is best for reversible conveyors. Self-aligning idlers of both types are also available for return run.

RETURN BELT IDLERS support the empty belt on the return run.

TO PROTECT THEM IN SERVICE

TROUGHED RUBBER CUSHION IDLERS (right) absorb impact under loading points, when large lumps and heavy materials are loaded on belt. Rubber tread return idlers, at left, simplify handling of tenacious materials.

WHETHER you handle cottonseed or coal—Link-Belt makes the exact size and type of belt conveyor idler you need. For top performance . . . lowest per-ton handling cost—see your nearby Link-Belt office or authorized stock-carrying distributor. Ask for Data Book 2416.

LINK-BELT

BELT CONVEYOR IDLERS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville (Sydney), N.S.W.; South Africa, Springs. Representatives Throughout the World. 14

Cleveland Cranes
FOR
STEEL MILL SERVICE
CLEVELAND CRANES
CLEVELAND CRANES
Modern All-Welded Steel Mill Cranes
5031 EAST 289th ST.
WICKLIFFE, OHIO

Crops *and* Shorts

THE 50th anniversary of the Association of Iron and Steel Engineers will be observed during the organization's annual convention in Pittsburgh, Pa., September 23–26. The Association has come a long way since it was founded 50 years ago by 28 pioneers in the steel plant electrical field. All of that way has not been easy.

Elsewhere in this issue is a brief history of AISE which we believe will be interesting to members and friends. It will remind the old timers of many incidents in their early careers, and it will acquaint the younger men with some of AISE's achievements. It is a history that reflects credit on the founders and the succeeding membership for their fine work in helping AISE serve their industry.

▲

THE group of Indian engineers sent to the United States to study our steel industry through the cooperation of the Ford Foundation, the Indian government and the American Iron and Steel Institute has started its introductory course at Carnegie Institute of Technology.

Of the 200 engineers, 75 will go to U. S. Steel, 40 to Bethlehem, 25 to Republic and 15 each to Jones & Laughlin, Youngstown Sheet & Tube, National and Inland. Additional class room work will be carried on at Carnegie, Lehigh, Case, Illinois Tech and Youngstown.

Similar groups will go to other countries: 250 to England, 200 to West Germany and 686 to Russia.

The plan was set up because India needs 2200 supervisors to take care of their expanding steel industry. The present capacity of 1,500,000 tons per year will be increased by a 1,000,000-ton plant being built by American engineers for private capital and by three 1,000,000-ton plants built respectively by England, West Germany and Russia, to go into production in 1959–61.

▲

A DISILLUSIONED husband says that if you give some women enough rope, they'll hang another clothesline in the bathroom.

▲

UNITED States Steel's Pittsburgh & Conneaut Dock Co. established an all-time high in July by unloading 2,119,169 gross tons of iron ore. The flow has since tapered off.

▲

IT IS interesting to note that the Lake Superior ore fields, which once supplied 80 to 85 per cent of the total U. S. ore now provides only 60 to 65 per cent.

A FRIEND of ours defines a specification as a collection of loopholes loosely held together by wistful verbiage.

▲

THERE are now 33 oxygen converter units operating or under construction outside the Iron Curtain. Eight of these, representing 30 per cent of the capacity, are in the United States, three (10 per cent of the capacity) in Canada, three (9 per cent) in India, five (16 per cent) in Japan, and 14 (35 per cent) in Europe. It is expected that 7,000,000 tons of steel will be made by this process in 1958.

Two more 80-ton units have just been ordered for installation in the United States.

▲

WE THOUGHT we'd heard of every possible cause of inflation until one of our correspondents mentioned "asset indigestion."

▲

CUTBACKS in aircraft plants have resulted in layoffs for a considerable number of years. In recent years, the aircraft industry has been criticized for its expensive recruiting and high salaries, and for "hoarding" engineers with very light work loads. Much of this was blamed on the "cost plus" contracts under which the industry operated. Now, unfortunately, many of the men laid off are unwilling to move or to accept salary cuts.

▲

YOU can judge the true objectiveness of your mind by whether the word "Bikini" reminds you of an atoll or nothing atoll.

▲

GENERAL Douglas MacArthur warned that, if present high government spending, high taxes and inflation continue unchecked, freedom of the individual will be seriously endangered. If the financial output of the government must be increased in one segment, he says it must be decreased in another.

Sounds like sense, if we can persuade the right people.

▲

THE Senatorial Committee investigation of steel prices has emphasized some things to think about:

From 1940 through 1956, U. S. Steel's product output per man-hour went up 56.3 per cent, or a rate of 2.7 per cent compounded annually, while in the same period its labor cost per man-hour (up 211 per cent) rose at the annually compounded rate of 8.1 per cent.

In the past 17 years U. S. Steel has suffered a deficiency of $900,000,000 between its wear and exhaustion allowance and the amount needed for replacement.

▲

TASTES change as we mature. Little girls like dolls; little boys like soldiers. They grow up and the girls like soldiers and the boys go for dolls.

▲

UNITED States Steel Corp. has brought out the seventh edition of "The Making, Shaping and Treating of Steel," the most widely used book in its field. Its 932 pages will, by contrast, remind many of us of the small early editions we used as college textbooks.

Westinghouse-equipped

d 20-ton crane built to work 60 minutes every hour

moving skelp loads at Jones & Laughlin's modern new tube mill

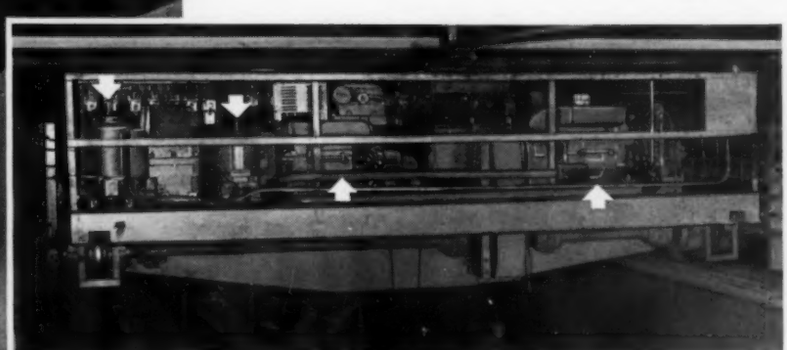
Outfitted with a C-hook, this new Movable Bridge Crane handles 9,250-pound coils of welded tube skelp, two at a time, in almost constant duty. Westinghouse silicone-insulated mill motors, fast-acting crane control and brakes are fully coordinated to give this unit the rugged stamina and positioning accuracy for continuous handling of big loads.

The low-inertia armature of the 600 Type MC mill motor assures quick response. Outstanding hoist control features an armature shunt point for light hook speed, *plus* an anti-cycling relay to prevent pumping in or out of the limit switch zone. Exclusive Westinghouse self-adjusting d-c magnetic brakes are used to assure positive braking when handling heavy loads. Westinghouse years of experience and engineering leadership have developed the industry's finest and most complete line of motors and controls for heavy-duty mill crane and hoist applications.

For all the facts, call your local Westinghouse sales engineer or write Westinghouse Electric Corporation, P. O. Box 868, 3 Gateway Center, Pittsburgh 30, Pennsylvania. J-22029

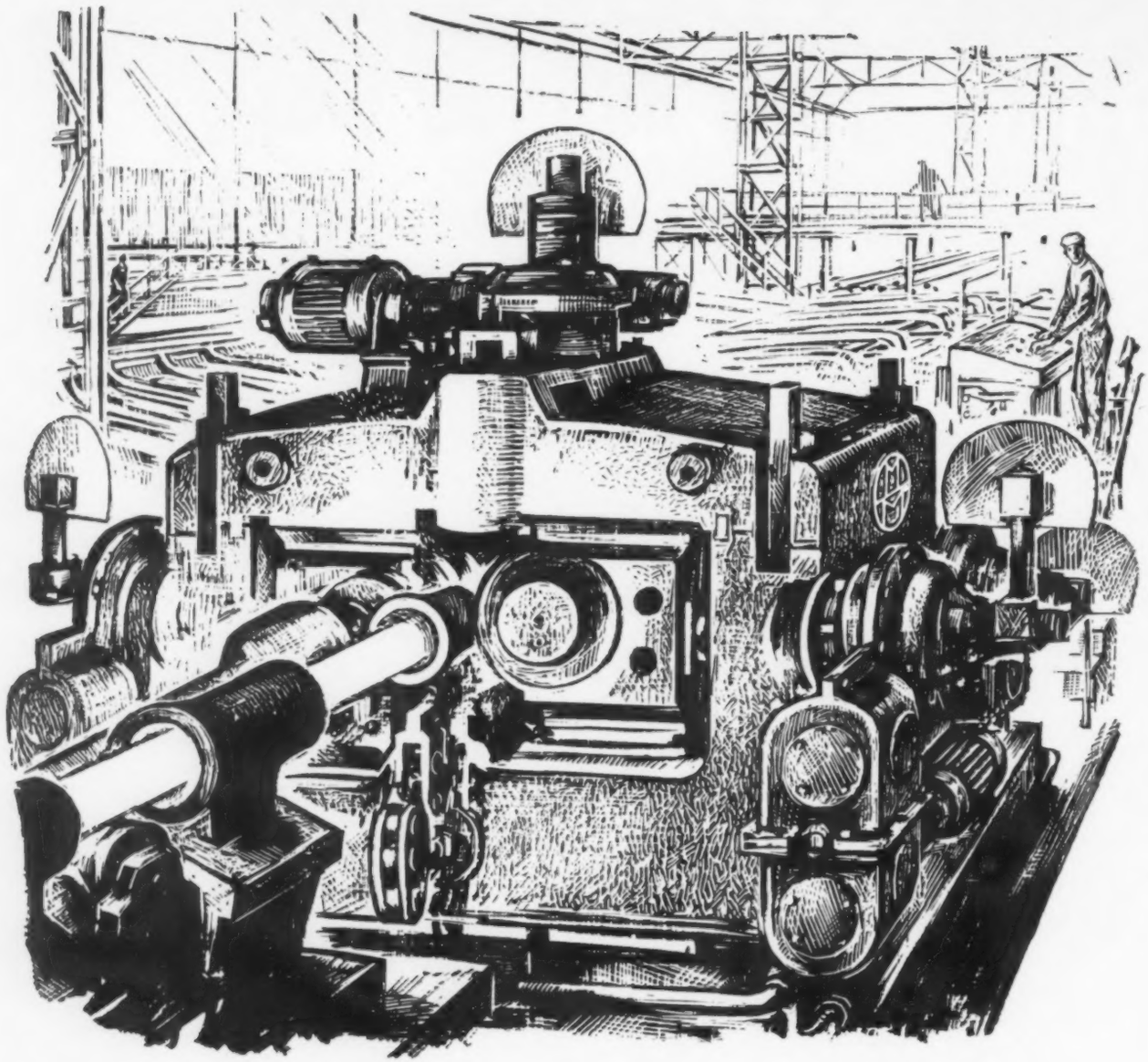
YOU CAN BE SURE...IF IT'S

Westinghouse



Crane is equipped with Westinghouse d-c mill motors to power bridge and trolley as well as the 20-ton main hoist and auxiliary 5-ton hook. Westinghouse SA brakes are completely self-adjusting—no adjustment or maintenance is ever necessary with wear.

Westinghouse Type M d-c contactors and AZ relays assure millions of trouble-free make-breaks for dependable service in continuous steel mill duty. Self-cleaning, knife-edge bearings guard against dust and dirt.



Do You Think Your Reelers Are Heavy Enough?

Most seamless mill operators do not think so! Attempts to speed up production of automatic seamless mills usually are stopped at the reelers because they are not heavy enough to take on more work at higher speeds.– Mannesmann-Meer's modern automatic seamless mills are equipped with heavy reelers of the most advanced design. Working rolls have angular adjustment in both planes to allow for variation of the feed angle which will provide ideal rolling of a wide range of sizes and grades of steel. With Mannesmann-Meer reelers it is possible to roll with an expanding pass and still to get good smoothing action.–

Mill design is considerably simplified by driving each roll with a separate motor. A rugged inlet table design features closed barrel guides to end danger and trouble from split guides. Roller type mandrel bar steadiers make possible smoother reeling operation.– In addition to all of these features Mannesmann-Meer reelers are especially designed for quick schedule changeovers.

Why don't you call us in to see what Mannesmann-Meer's outstanding combination of

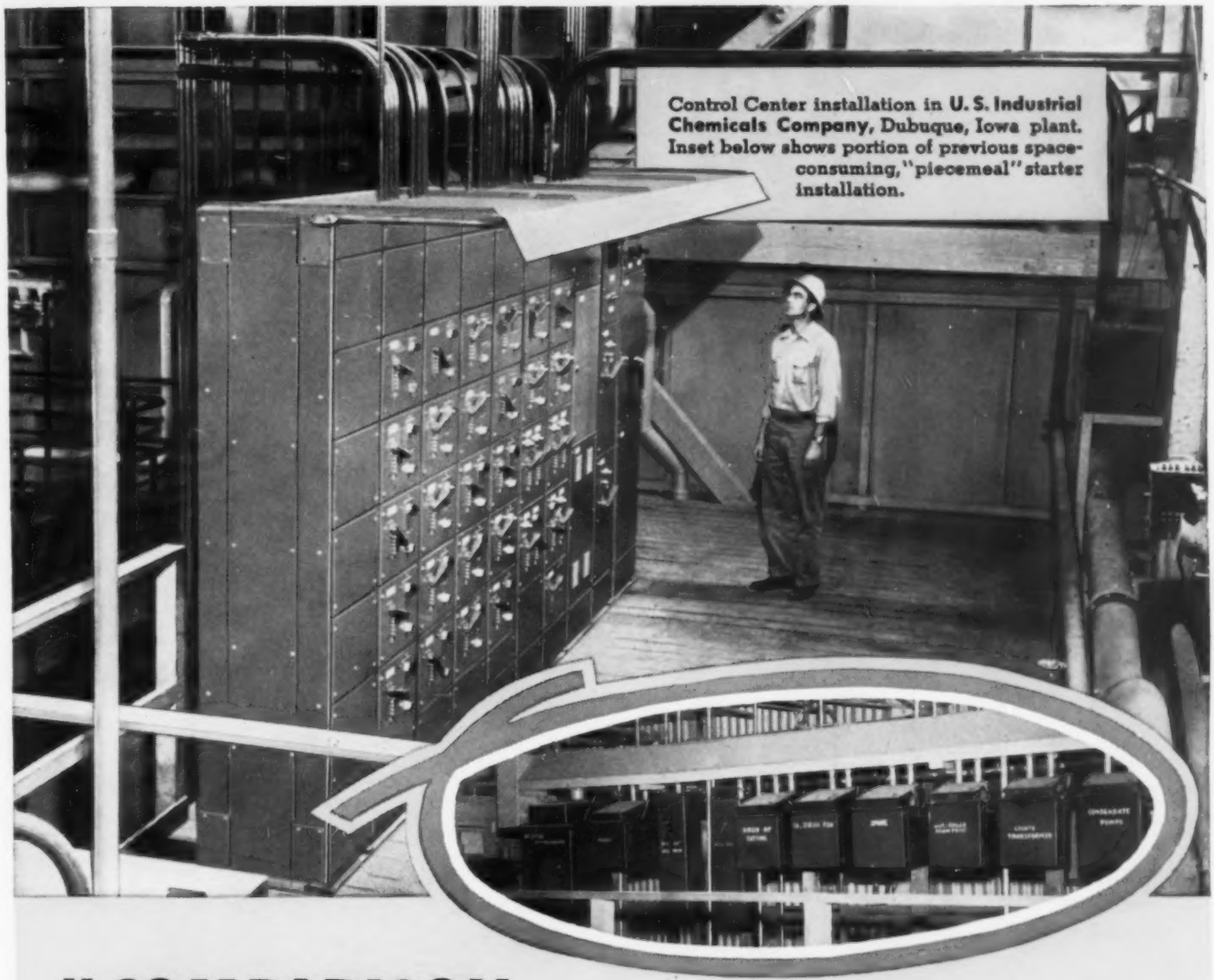
- CREATIVE ENGINEERING
- DESIGN EXPERIENCE
- OPERATING BACKGROUND
- AMERICAN MANUFACTURING SKILL

can offer you to modernize your seamless mill.

MANNESMANN-MEER

ENGINEERING AND CONSTRUCTION COMPANY, 900 LINE STREET, EASTON, PENNA

WORLD SPECIALISTS IN HIGH-SPEED TUBE MILL MACHINERY



Control Center installation in **U. S. Industrial Chemicals Company**, Dubuque, Iowa plant. Inset below shows portion of previous space-consuming, "piecemeal" starter installation.

"COMPARISON convinced us that a SQUARE D Control Center offered us MORE!"

These design features make Square D your logical choice, too...

INCREASED SAFETY because bus bars are fully enclosed, rigidly supported and have ample cross section. Circuits are isolated by individually enclosed plug-in units. Disconnect handle designed for maximum operator protection.

FLEXIBILITY. Individual plug-in units or complete sections are easily added, removed or exchanged. Pushbuttons, pilot lights, and selector switches are readily added to unit doors.

INSTALLATION ECONOMY. All wiring channels are large and accessible from front without removing units. No "wire fishing."

SPACE ECONOMY, TOO. Up to six combination starters fit in a 20" x 20" x 90" section. Plug-in unit heights designed in space-saving increments of 3 inches.

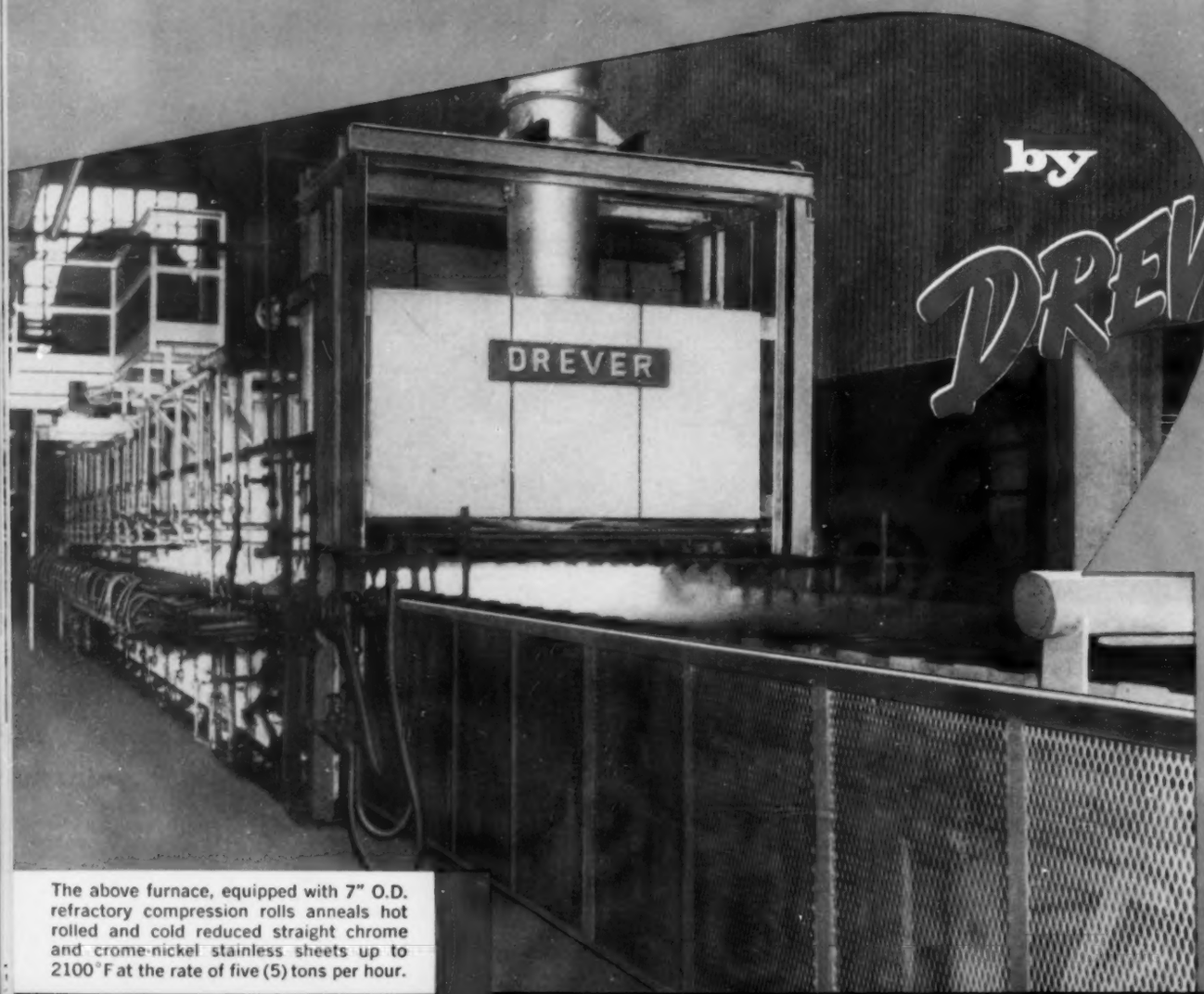
NOW...EC&M PRODUCTS ARE A PART OF THE SQUARE D LINE!

SQUARE D COMPANY

ROLLER HEARTH
FURNACES

for Operation at 2300°F
Utilizing Drever Refractory Compression Rolls

by DREVER



The above furnace, equipped with 7" O.D. refractory compression rolls anneals hot rolled and cold reduced straight chrome and crome-nickel stainless sheets up to 2100°F at the rate of five (5) tons per hour.

The success in utilizing the Drever Refractory Compression Roll in annealing stainless steels has been attributed to the roll strength and its resistance to pickup which completely eliminates the necessity of using rider sheets. The refractory rolls are prestressed and consist of silicon carbide sections retained by spring loaded alloy ends to allow for expansion and to provide axial forces to insure structural stability under rated load. Furnaces have been installed with roll sizes varying from 4½" O.D. x 20½" long to 14" O.D. x 14'-6" long.

In addition to annealing stainless steel sheets, plates, bars and tubing, materials have been successfully heat treated at 2300°F. Avail yourself of the experience of Drever Company engineers in solving your stainless steel annealing problems.

DREVER COMPANY

RED LION ROAD and PHILMONT AVE., BETHAYRES, PA.

UNITED®

6 stand continuous horizontal

and vertical Billet Mill

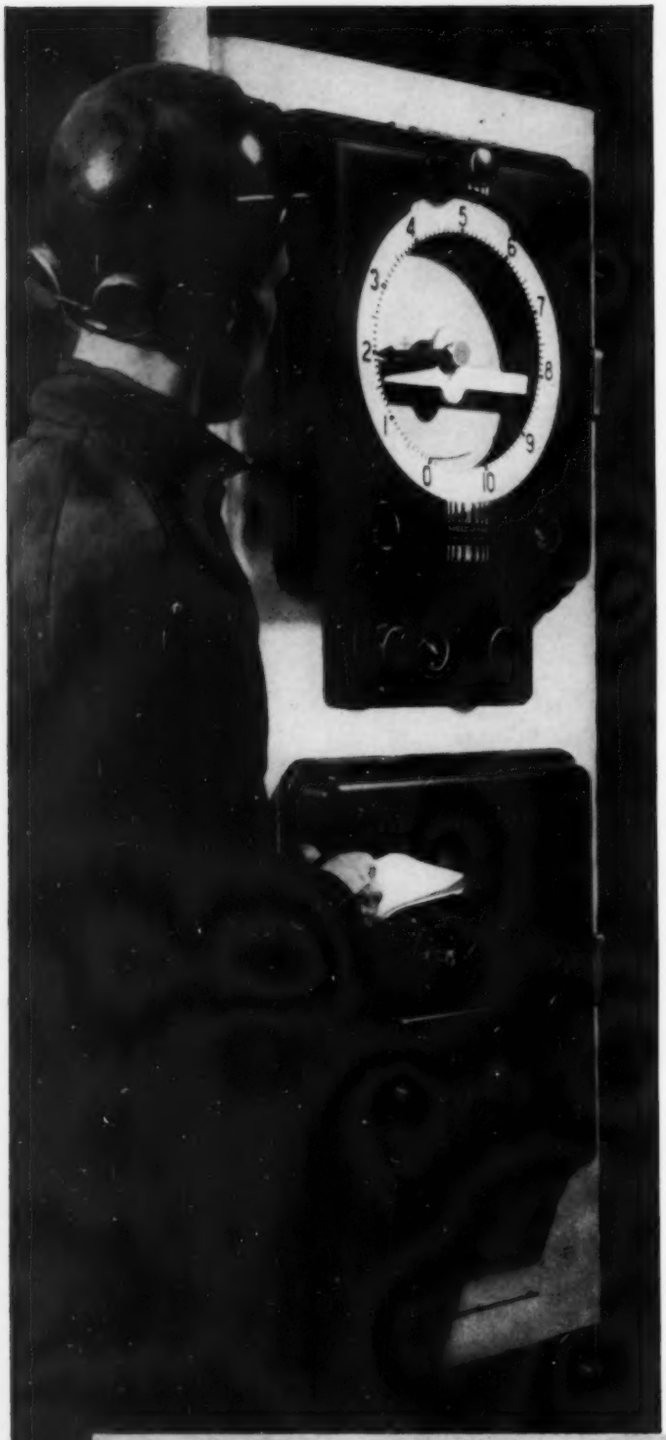
UNITED ENGINEERING AND FOUNDRY COMPANY

Pittsburgh, Pennsylvania

Plants at PITTSBURGH • VANDERGRIFT • YOUNGSTOWN • CANTON • WILMINGTON

Subsidiaries: ADAMSON UNITED COMPANY, AKRON, OHIO
STEDMAN FOUNDRY AND MACHINE CO., INC., AURORA, INDIANA

Designers and Builders of Ferrous and Nonferrous Rolling Mills, Mill Rolls, Auxiliary Mill and Processing Equipment, Presses and other Heavy Machinery. Manufacturers of Iron, Nodular Iron and Steel Castings, and Weldments.



For improved O-H combustion practice...

Record O_2 Reliably, Heat after Heat

Key to continuous, reliable records of oxygen in open-hearth exhaust gases is the unique L&N sampling system. Self-flushing, self-cleaning, this assembly delivers a thoroughly scrubbed sample of waste gas to the L&N Magnetic Oxygen Analyzer under positive pressure, without mechanical pumps or aspirators . . . and with very little maintenance.

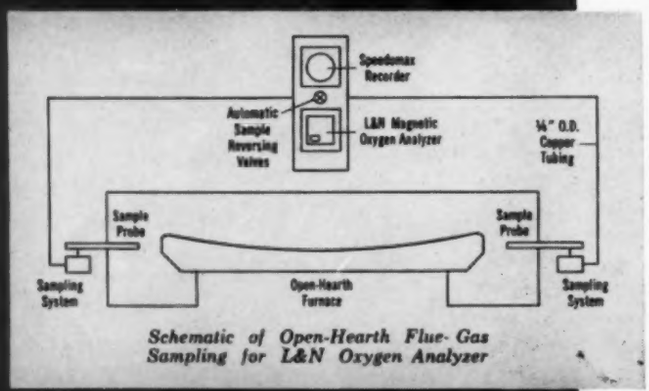
Spray-flushing of the probe opening and internal passages prevents slag buildup and dirt accumulation. The sample gas is drawn from the water-jacketed, stainless steel probe by a steam jet assembly. Expansion of steam accelerates the gas to a high velocity; condensation of the steam scrubs the sample by precipitating all dust and dirt. The cleaned sample travels at 50 ft./sec. in the sampling lines (quarter-inch copper tubing), so that initial response of the *entire* system is only about 10 seconds.

The Magnetic Oxygen Analyzer and the Speedomax G® recorder, calibrated directly in per cent O_2, may be located wherever convenient . . . are quickly checked against air to assure accurate performance.

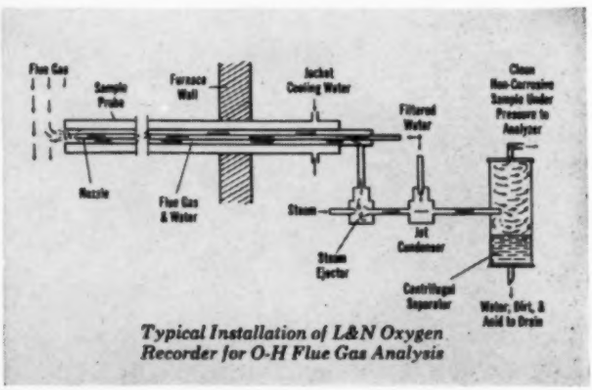
Complete description of this equipment is contained in Process Data Sheet 643(5), available from your nearest L&N representative. Or write us at 4942 Stenton Avenue, Philadelphia 44, Pa.

LEEDS NORTHRUP
Instruments Automatic Controls • Furnaces

In this O-H shop of Jones & Laughlin Steel Corp., Pittsburgh, the L&N O_2 Analyzer is used with a Speedomax G Controller, which adjusts a fuel-air controller (not shown) to provide automatic combustion control.



Schematic of Open-Hearth Flue-Gas Sampling for L&N Oxygen Analyzer



Typical Installation of L&N Oxygen Recorder for O-H Flue Gas Analysis

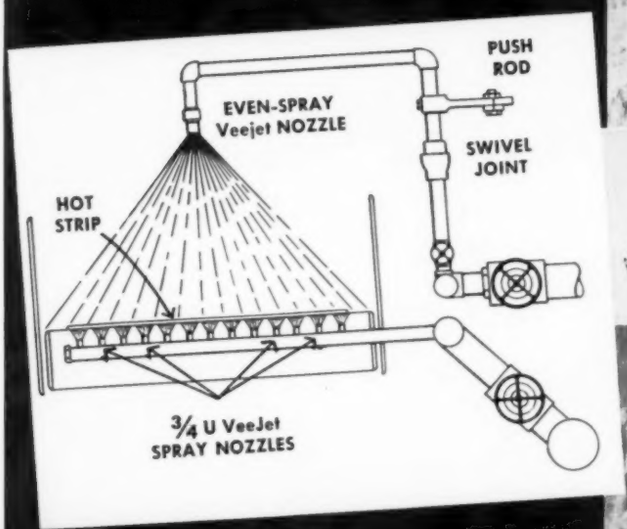
SPRAYING SYSTEMS

SPRAY NOZZLES

FOR

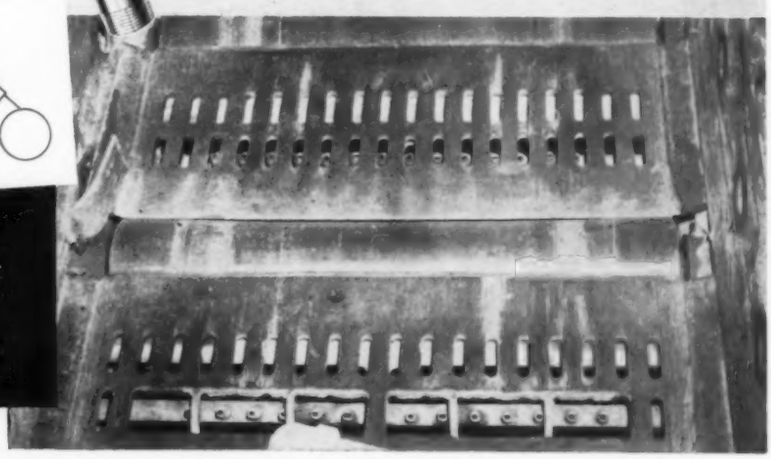
Hot Strip Spray Cooling

• AND ROUGHING STAND ROLL COOLING, **DESCALING** AND RELATED SPRAYING OPERATIONS

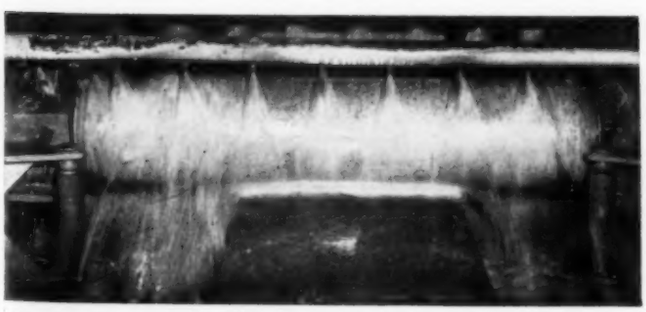


AT THE
PORTSMOUTH DIVISION PLANT
PORTSMOUTH, OHIO OF THE
DETROIT STEEL CORPORATION

• Large capacity Even-Spray VeeJet Spray Nozzles are mounted above the cooling table. Each nozzle covers entire strip width . . . provides 170 GPM at 80 psi. Smaller VeeJet nozzles are mounted in manifolds below table; capacity of each nozzle is 14 GPM at 5 psi.



• One of the most interesting nozzle installations at Detroit Steel's Portsmouth plant is the system for cooling hot strip. Using Spraying Systems nozzles above and below the first 120′ of the 360′ runout table length, effective steam barrier penetration helps reduce strip temperature as much as 500 degrees between finishing stand and coiler. Cobbles cannot endanger the system since the overhead nozzles are gang mounted on risers with swivels, and swing out of the way when necessary. Not one nozzle has been lost or replaced in over six months of operation. For greater efficiency and lower costs, Spraying Systems nozzles are also employed in such other applications as descaling . . . and roll cooling as shown at left. For complete information on Spraying Systems spray nozzles, we invite your inquiry for Catalog 24 . . . or for the special data sheet folder "Steel Mill Applications."



SPRAYING SYSTEMS CO.
3262 RANDOLPH STREET • BELLWOOD, ILLINOIS

TSP in service

TSP sheave wheels on slab yard crane

"Tool Steel Process" hardened products are widely used in every department of Granite City Steel Co., Granite City, Illinois. They include TSP gears, pinions, track wheels, rolls, sheaves, drums, brake wheels, screws, nuts, etc. The phenomenally long life of TSP products has prompted Granite City Steel Co. to specify and use them wherever extremely severe operating conditions occur.

TSP products are specifically designed, produced and guaranteed to out-perform, outlast any competitive product. Their superiority has been established by service tests in the nation's leading steel mills. A special hardening process achieves a file hard surface to the full depth of permissible wear, combined with a core refined for toughness and ductility.

TSP track wheels, gears and pinions throughout 10 ton scrap yard crane

TSP wheels and gearing on 325 ton ladle crane

TSP rolls and gears on processing and shearing line

TSP brake wheels on 25 ton crane installed in 1944. Twenty-two

TSP screw down screws and nuts on 46" blooming and

TSP track wheels and gears on coke pusher

TSP gears and leveller rolls on 1/4" shear line

since 1918 at GRANITE CITY STEEL

Enjoy the tremendous savings in operating and maintenance costs you receive when you use TSP hardened products. Write for information.

THE TOOL STEEL GEAR AND PINION CO.
CINCINNATI 16, OHIO, U. S. A.

The World's Standard of Quality
Since 1909 for Gears • Pinions •
Rolls • Wheels • and Other
Hardened Products

TSP wheels on blast furnace skip cars

AD 1025
Printed in U.S.A.

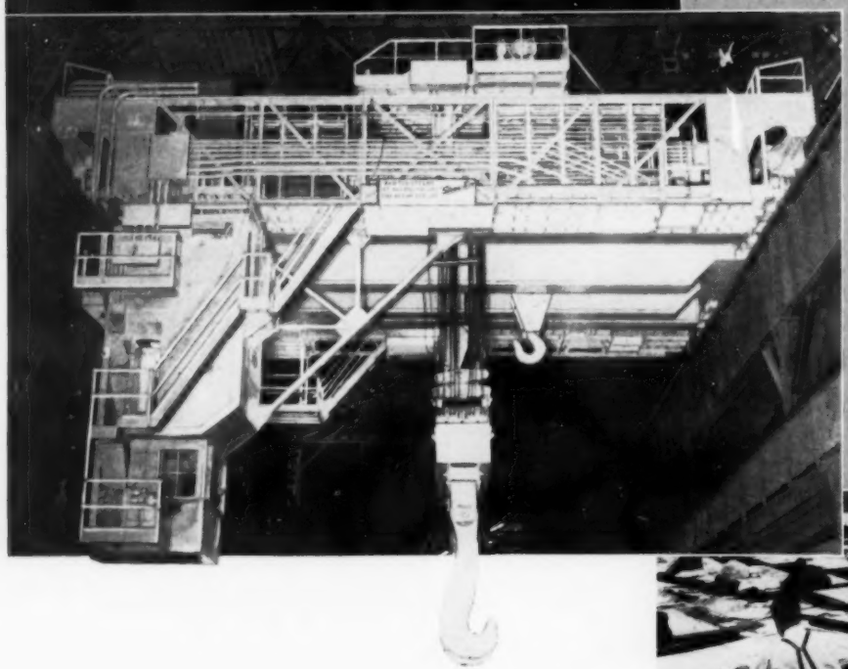
TSP mill pinions drive 56" four stand cold reduction mill

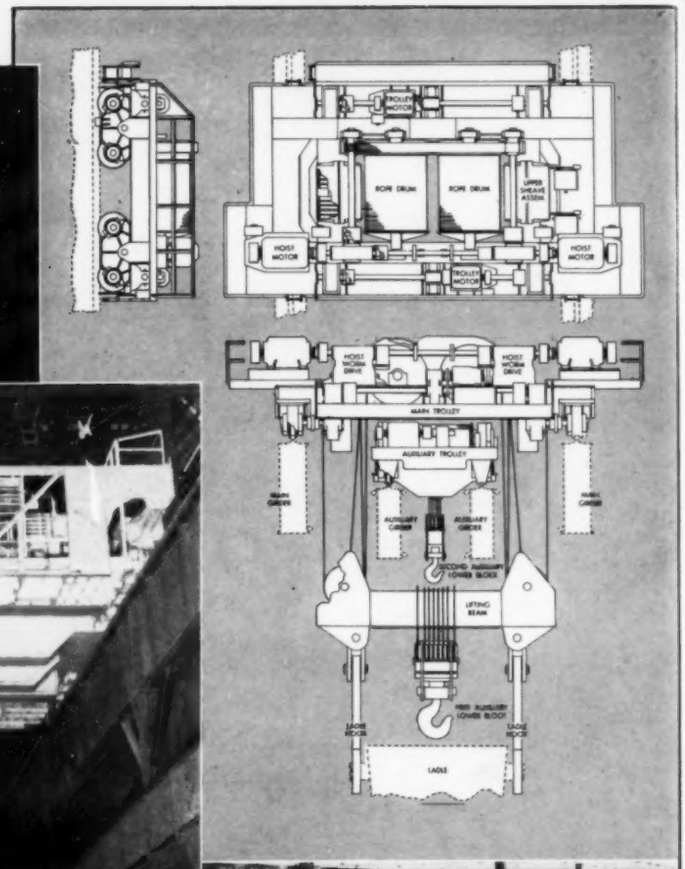
Gene Whitaker, Chief Mech. Engineer, points to long wearing TSP edger screws on

TSP gear drives and leveller rolls on shear and leveller

"SHAW-BOX" CRANES

built to AISE Specs or your own





Complete dependability. Economical operation. Convenient maintenance. "Shaw-Box" Cranes are demonstrating these essentials effectively in steel mills all over the country every day. Whether built to mill or AISE Standard No. 6 Specification, "Shaw-Box" Cranes give years of reliable performance in the toughest services.

The giant "Shaw-Box" Ladle Crane pictured here raises a 90-ton ladle containing 200 tons of molten steel. A 75 ton auxiliary trolley, also a part of the unit, operates independently for handling of lighter loads. It is a 4-girder, 9-motor crane with a 54-foot span. Creative engineering contributes *exclusive* structural, mechanical and operational advantages that assure rugged strength and functional perfection.

Make certain of experienced interpretation of your requirements, whether your plans include a ladle crane, a soaking pit carriage or a crane to handle plate or slabs. Our vast crane-building facilities and special manufacturing techniques can be of real value to you. We have standard AISE designs for 15 to 100-ton cranes, so you pay less for engineering and get more for your purchase dollars. Invite one of our engineers to discuss specifications. No obligation, of course.

57K-4

MANNING MAXWELL & MOORE INC. M&M TRADE MARK

"Shaw-Box"® CRANES

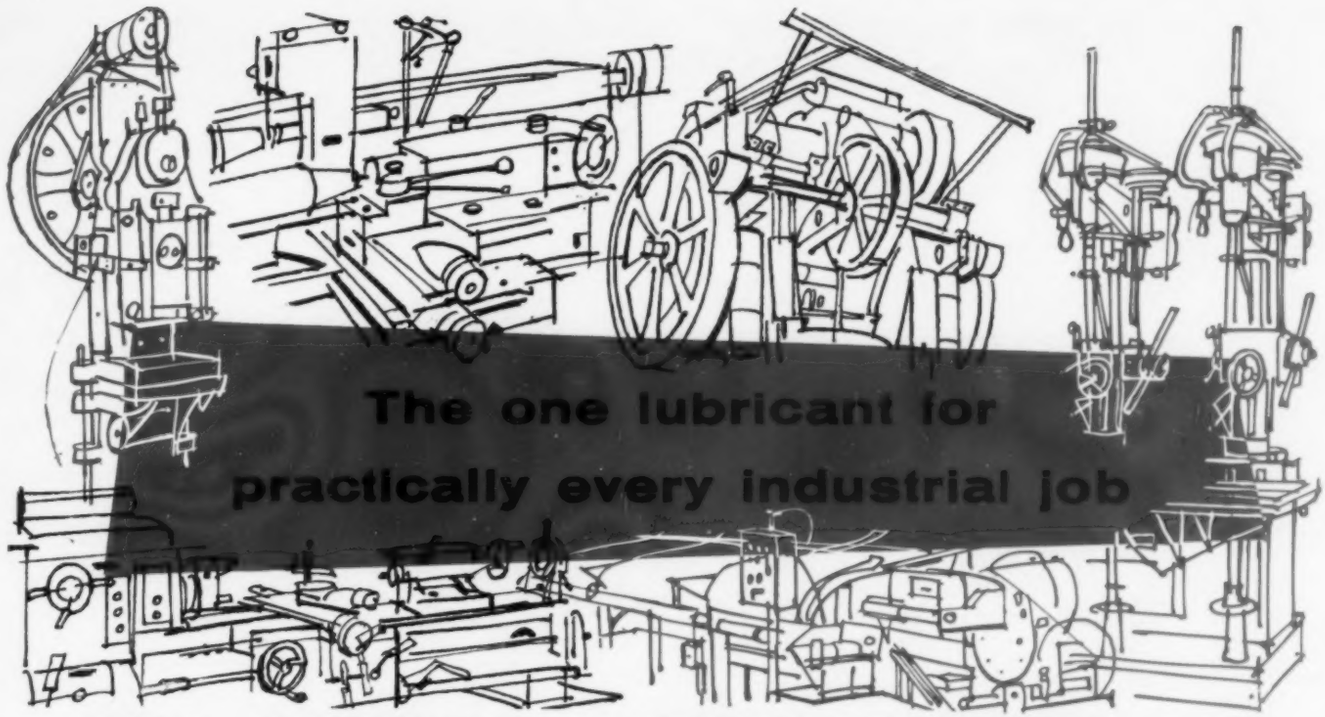
MANNING, MAXWELL & MOORE, INC.

SHAW-BOX CRANE & HOIST DIVISION

388 West Broadway • Muskegon, Michigan

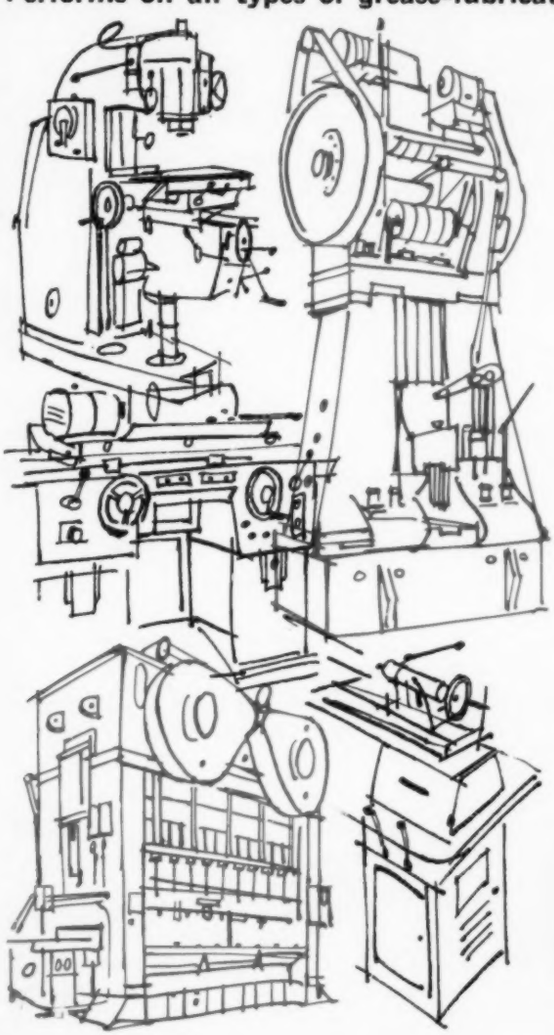
Builders of "SHAW-BOX" and 'LOAD LIFTER' Cranes, 'BUDGIT' and 'LOAD LIFTER' Hoists and other lifting specialties. Other Divisions produce 'ASHCROFT' Gauges, 'HANCOCK' Valves, 'CONSOLIDATED' Safety and Relief Valves, 'AMERICAN' and 'AMERICAN-MICROSEN' Industrial Instruments, and Aircraft Products.

In Canada: *Manning, Maxwell & Moore of Canada, Ltd., Avenue Road, Galt, Ontario*



ATLANTIC LUBRICANT 54

Performs on all types of grease-lubricated machinery • Cuts cost • Reduces lubricating errors



Atlantic Lubricant 54—an outstanding multi-purpose lubricant—assures:

- **Wider application**—almost universal application to grease-lubricated equipment in plants of all sizes
- **Excellent performance** at very high to extremely low operating temperatures
- **Reduced losses** from lubricating error
- **Lower costs** of warehousing and handling
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- **Unusual stability** against oxidation and softening—even under very rugged conditions
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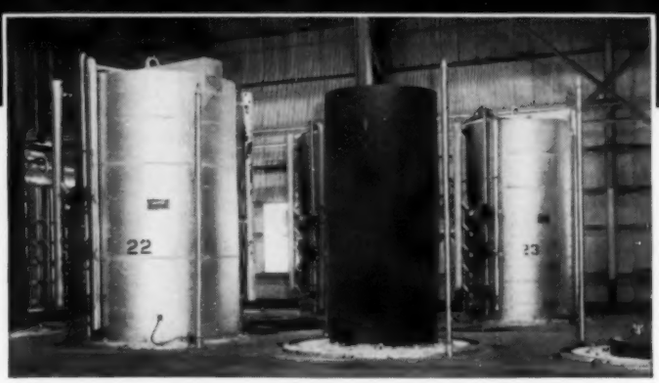

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Patent Reviews

by
MELVIN NORD
Patent Attorney,
Detroit, Mich.

. . . . copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C., at 25 cents. . . . patents reviewed cover period April 2, 1957 through April 23, 1957. . . .

PRODUCTION OF IRON CONTAINING MANGANESE

▲ U. S. 2,787,535, issued April 2, 1957, to Robert Doat, Karl Heimberg, and Max Paschke, assigned to Compagnie Generale de Conduites d'Eau, describes a process for producing manganese-containing iron, using relatively inexpensive materials.

Scrap iron or cast iron containing silicon is melted in a reducing atmosphere in a hot-blast cupola, and passed through a bath of molten manganiferous slag. The manganese content is reduced by the silicon, thus obtaining iron with a high manganese content.

ROLLING SHEETS

▲ U. S. 2,787,046, issued April 2, 1957 to James B. Wagstaff, describes a process for rolling steel sheets to reduce the thickness and increase the width of the sheets.

As shown in Figure 1, two sheets A and B are forced into the nip of a set of rolling planetary rolls 14 and converge at a point 16 in the nip of the rolls. The thickness of the sheets is reduced and the rolled sheets issue from the mill as individually wider sheets or, if fused by a torch, as a single sheet wider than the sum of the widths entering the roll.

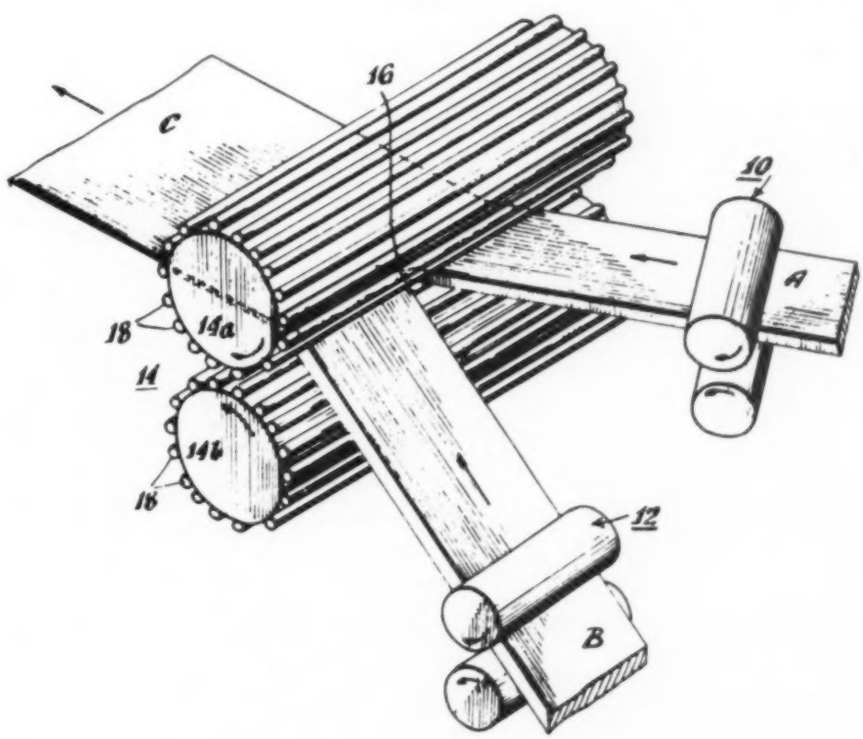
SOAKING PIT CONTROL

▲ U. S. 2,788,175, issued April 9, 1957 to Rudolf Bourek and Paul L. Wachendorfer, Sr., describes a control system for determining when an ingot in a soaking furnace has been heated through to the desired temperature.

As shown in Figure 2, a safety thermocouple 4 inserted into the soaking pit 1 is connected to a control 5 which is set for a maximum safe temperature. When this temperature is exceeded, control 5 automatically shuts off the fuel and lights a red light 6.

Another thermocouple 7 is also inserted into the furnace, and is connected to a temperature regulator 8, which is in turn connected to a motor 9 which operates a valve 10 in the fuel line 11. Thus, the fuel flow is regulated so as to maintain the desired temperature in the furnace, as indicated by thermocouple 7. Also connected to thermocouple 7 is a device which actuates a green light 14 when the control temperature is reached.

Figure 1



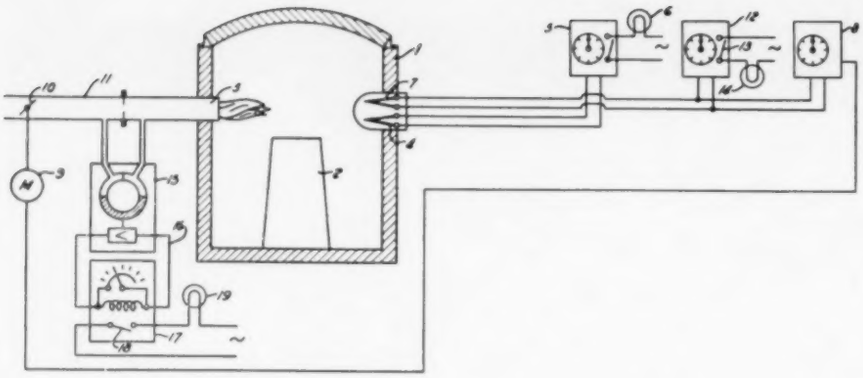


Figure 2

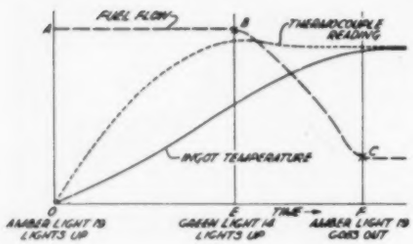


Figure 3

A device for measuring and indicating the fuel flow is indicated at 15. Current flowing in the circuit 16 is directly proportional to the flow of fuel. Circuit 16 is connected to an adjustable relay 17. This relay 17 is set so as to close a switch 18 when the fuel flow exceeds a value corresponding to that required to replace the predetermined heat losses from the furnace. When switch 18 is closed, current flows through an amber light 19.

After an ingot 2 is placed in the furnace, the operation of the furnace is indicated in Figure 3. When the reading of thermocouple 7 indicates that the furnace has reached the control temperature, the fuel flow automatically begins to decrease, so as to maintain this temperature constant. So long as the fuel flow is decreasing, this indicates that the ingot is still taking up heat. When the fuel flow levels off at the amount necessary to make up for heat losses from the furnace, it is clear that the ingot is up to temperature. In other words, the ingot is completely "soaked," and it can be removed from the furnace.

BLOOM-TUMBLING TOOL

▲ U. S. 2,788,237, issued April 9, 1957 to Bromislaw Misiura, assigned to United States Steel Corp., describes a tool in the nature of a cant-hook for tumbling or rotating heavy steel billets and blooms.

The tool is shown in Figure 4.

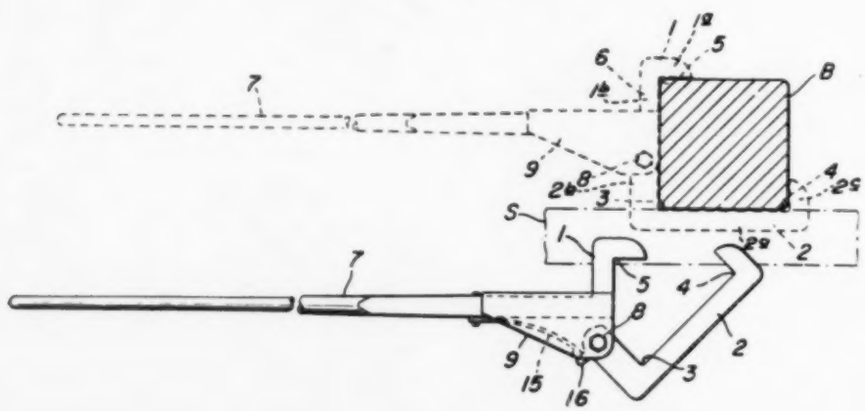
COATING OF STEEL BEFORE DRAWING

▲ U. S. 2,788,301, issued April 9, 1957 to Eldon B. Moore and Elliot S. Nachtman, assigned to La Salle Steel Co., describes a method for improving the surface finish of steel, by coating the steel prior to drawing.

The steel is coated with molybdenum disulphide, heated to 300 to 1100 F, and subjected to a drawing process.

The coating reacts to produce a bright, shiny and smooth surface layer on the steel, and also acts as a lubricant to reduce the load required in the drawing process. The surface appears to be highly resistant to deterioration, dulling or attack by the atmosphere.

Figure 4



HOT-BLAST CUPOLA FOR PRODUCING PIG IRON

▲ U. S. 2,788,964, issued April 16, 1957 to Otto Schnyder, describes a hot blast cupola which is suitable for the production of pig iron from low quality and fine-ground ores, by fuels of relatively low quality.

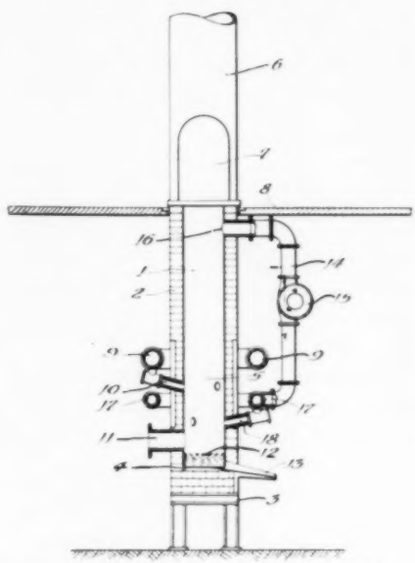


Figure 5

As shown in Figure 5, the hot blast is blown into the cupola through an annular pipe 9 and from there is introduced into the reduction zone 5 in a downward direction through nozzle 10. The gas outlet 11 in the lower portion of the shaft draws off most of the waste gases, which may be used to heat the fresh blast. The furnace is further provided with a duct 14 and a circulating fan 15, by which a secondary gas flow is obtained, the gases (hydrocarbons) being withdrawn at 16 from the upper portion of the furnace to be reintroduced into the combustion and reduction zone by means of the annular pipe 17 and nozzle 18.

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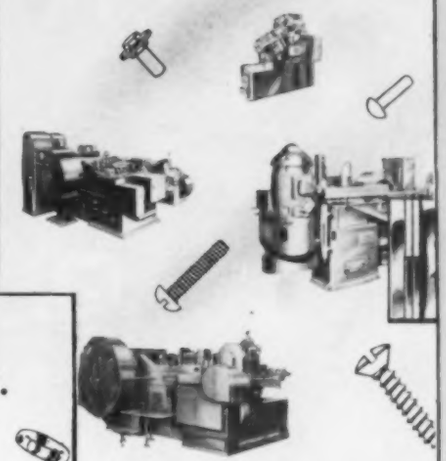

Machinery for mass production of standard and special bolts, nuts, rivets, screws and other cold formed parts.

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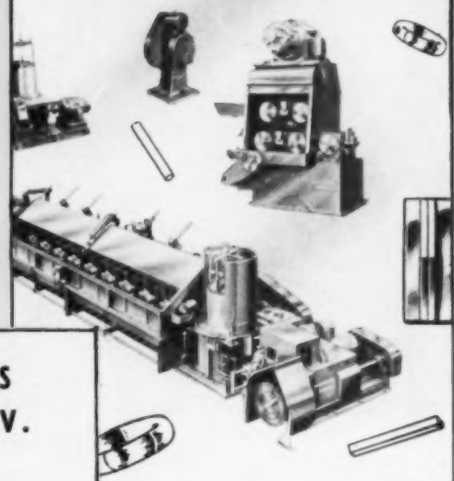

Machinery for the economical drawing of non-ferrous wire in heavy, intermediate and fine wire sizes.

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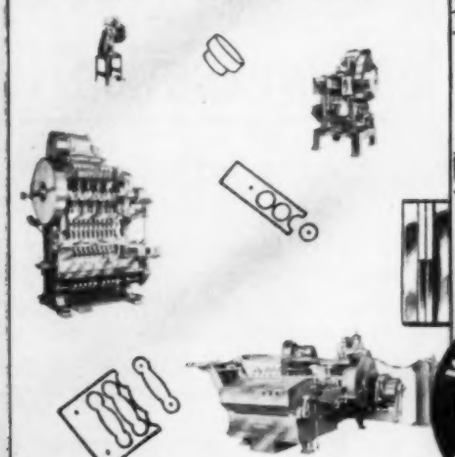

Machinery for quantity production of parts requiring blanking, stamping, forming, deep drawing, threading, trimming, beading or other operations.

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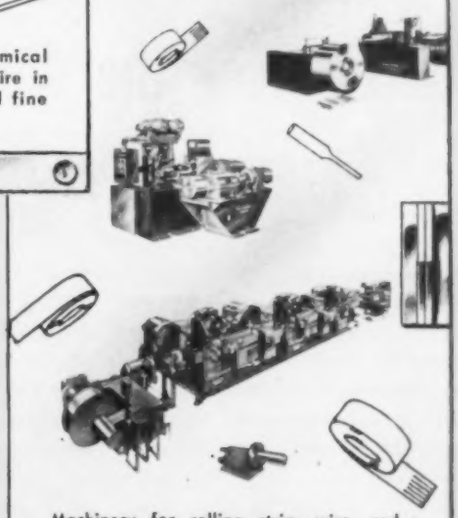

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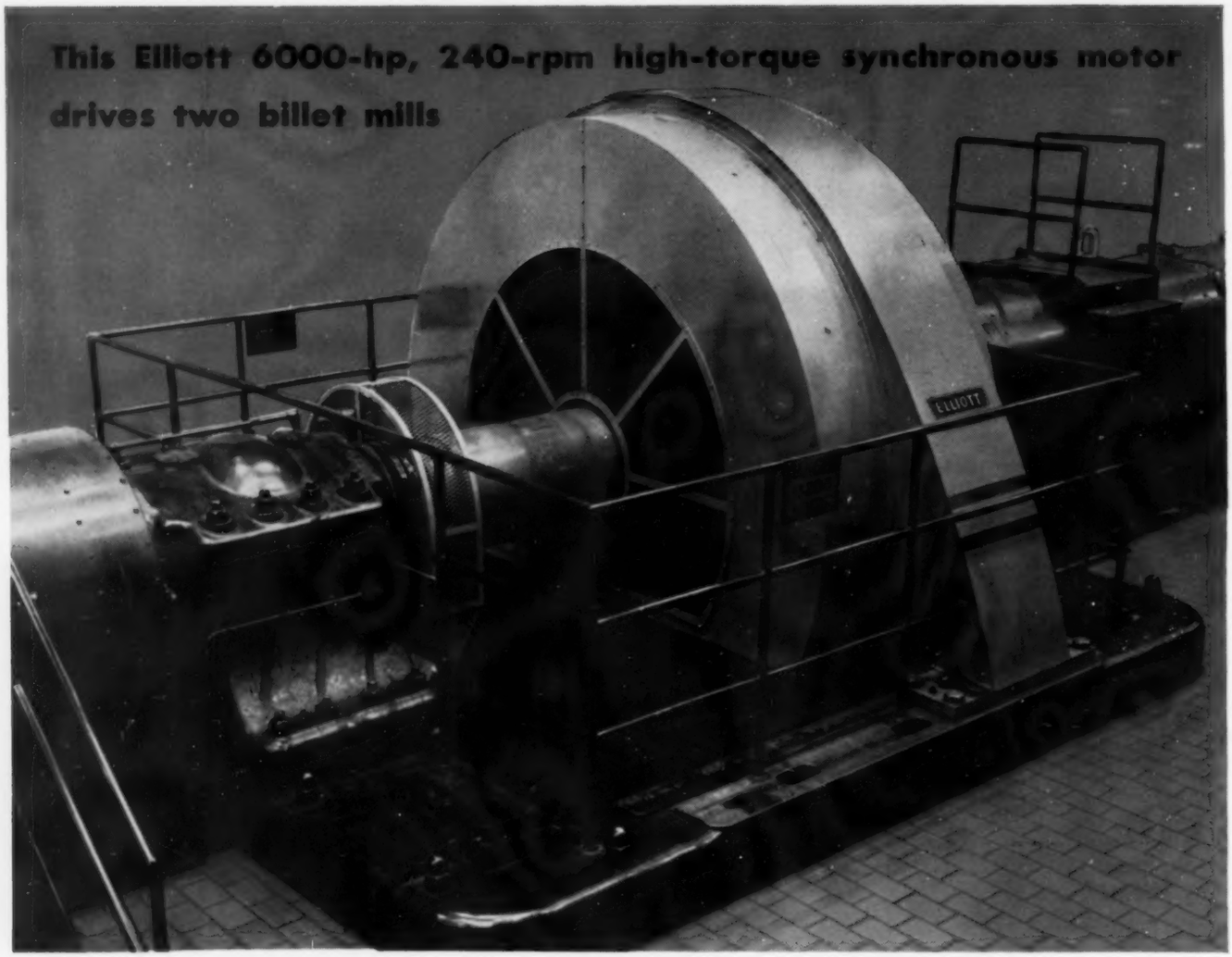


Installed over the weekend—no lost production time

designed to fit existing bearings and base

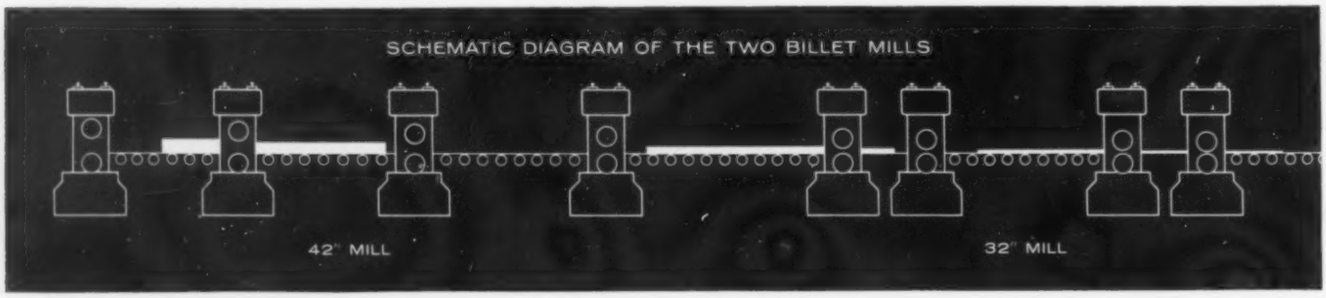
Come Monday morning, this Elliott 6000-hp high-torque synchronous motor was in operation. (On the previous Friday, power was still being furnished by an old wound-rotor motor.) The new Elliott motor drives, through gear trains, two billet mills, each containing four mill stands. The motor was engineered and built by Elliott to fit existing bearings and base, and the remarkably quick changeover reflects the excellence of Elliott engineering and workmanship.

Satisfactory experience with similar Elliott apparatus previously installed at this plant led to the selection of the Elliott motor for this billet mill drive.

ELLIOTT Company

Ridgway Division, Ridgway, Penna.

R7-24



OTHER PATENTS OF INTEREST TO THE IRON AND STEEL ENGINEER

Patent No.	Date	Subject	Inventor or Assignee
2,787,585	4/2/57	Production of metallurgical coke.	Kaiser Steel Corp.
2,788,204	4/9/57	Recuperative roller-type heating furnace	Stora Kopparbergs Bergslags A.G.
2,788,205	4/9/57	Baffle type heat-treating furnace.	Harold N. Ipsen
2,788,270	4/9/57	Vacuum melting furnace	Universal-Cyclops Steel Corp.
2,788,302	4/9/57	Nitriding stopoff composition	General Motors Corp.
2,788,750	4/16/57	Railway car underframe construction	United States Steel Corp.
2,788,861	4/16/57	Lubricating means for rolling mill coupling spindles	The Loewy Engineering Co.
2,788,896	4/16/57	Apparatus for gaging and classifying sheets such as tin plate	United States Steel Corp.
2,788,899	4/16/57	Apparatus for treating sinter sludge	Martin L. Cover
2,788,907	4/16/57	Dipper door structure	Electric Steel Foundry Co.
2,788,957	4/16/57	Refractory roller furnace conveyor system	Drever Co.
2,788,969	4/16/57	Apparatus for aligning strip material	Armco Steel Corp.
2,789,048-9	4/16/57	High-strength welding steels	The McKay Co.
2,789,069	4/16/57	Method of improving the machinability of steel	La Salle Steel Co.
2,789,086	4/16/57	Decarbonizing of the rich gas nozzles of coke ovens	Koppers Co., Inc.
2,789,450	4/23/57	Rolling mill	Ilario Properzi
2,789,779	4/23/57	Expansible and collapsible-core spool mechanism	Continental Steel Corp.
2,789,807	4/23/57	Galvanizing pot	Kolene Corp.
2,789,808	4/23/57	Controlling the circulation of furnace atmospheres	Lee Wilson
2,789,809	4/23/57	Sealing means for sintering machines	Arthur G. McKee & Co.
2,789,894	4/23/57	Pelletizing high-moisture ore	Pickands Mather & Co.
2,789,895	4/23/57	Agglomerating fine iron ores	Jones & Laughlin Steel Corp.
2,789,898	4/23/57	Production of cast iron	The Dayton Malleable Iron Co.

A temperature of 1800 C is obtained in the reduction zone, thus enabling the reduction of iron ores with ease.

The downward combustion also has the advantage that clogging of the furnace need not be feared when coal with a caking tendency is used.

OXYGEN PROCESS FOR STEEL PRODUCTION

▲ U. S. 2,789,046, issued April 16, 1957 to Karl G. Speith, Otto Darmann, and Hans vom Ende, assigned to Mannesmann Aktiengesellschaft, describes a method of producing higher quality steel or technically pure iron by blowing pig iron with pure oxygen.

The oxygen is first blown in at a high rate, in order to reduce the carbon content quickly and to avoid excessive foaming of the slag. The phosphorus content is at the same time maintained well below the carbon content.

The blowing rate is then reduced, to promote the dephosphorization of the melt. Finally, this is followed by a high rate of blowing to further decarburize and reduce the phosphorus content down to the desired level.

METHOD OF NITRIDING FERROUS ALLOYS

▲ U. S. 2,789,930, issued April 23, 1957 to William F. Engelhard, describes a method of nitriding articles of ferrous alloys having a high chrome content.

As shown in Figure 6, articles to be nitrided 10, 11 are placed in a chamber 15 on wire supports 16,17. The chamber 15 is itself in a furnace 19, closed by a cover 21.

Ammonia gas is circulated in chamber 15, entering from a source 22 and being pumped out through pipe 26 and outlet 27.

There is placed in the chamber 15, along with the work, a mass 40 of mineral wool soaked with hydrochloric acid. The furnace is heated to its operating temperature (920 to 1150 F) for the desired number of hours, to nitride the articles 10 and 11.

The hydrochloric acid fumes emanating from mass 40 combine with

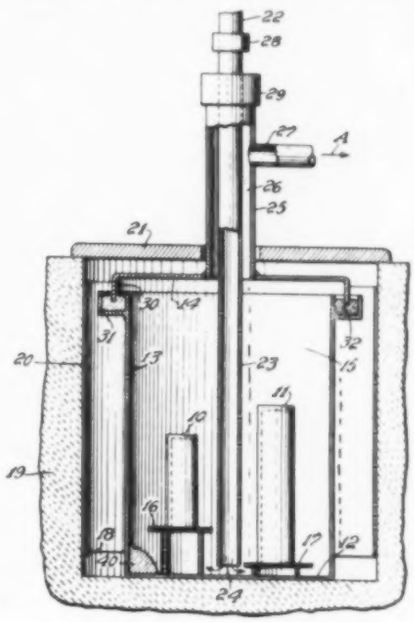


Figure 6

the ammonia gas to form ammonium chloride vapors which sweep over the articles 10,11, condensing on them, and attacking the chrome oxide film barrier on them. Eventually, as the articles approach nitriding temperature, the condensed ammonium chloride is vaporized and the articles are then cleanly exposed to the ammonia gas. The ammonia gas sweeps out the volatilized ammonium chloride, and is then available for nitriding.

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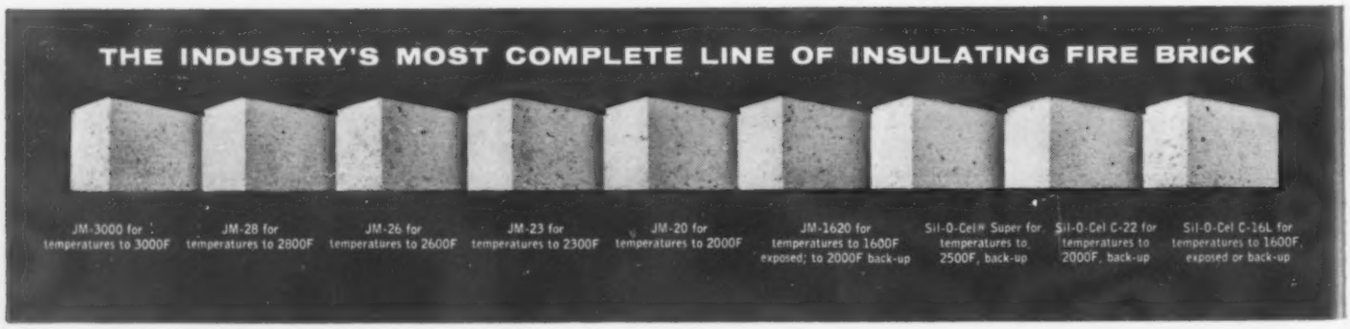
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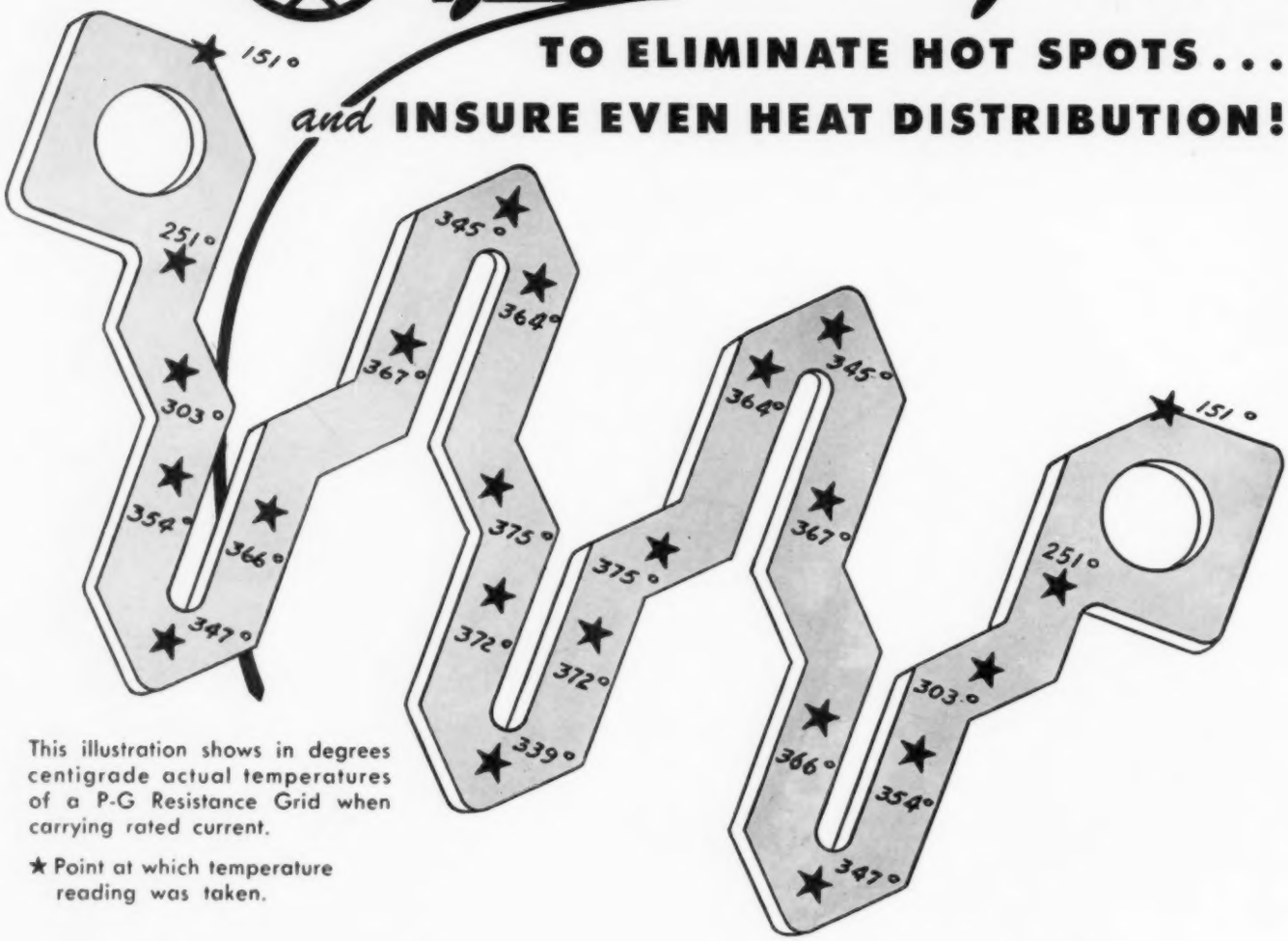

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★ Point at which temperature reading was taken.

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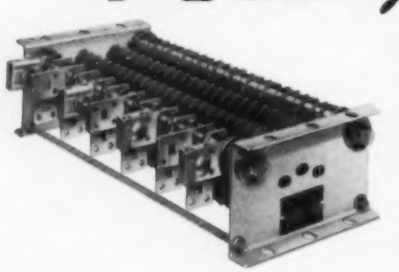

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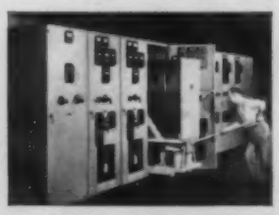

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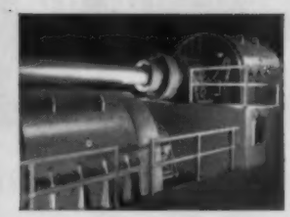

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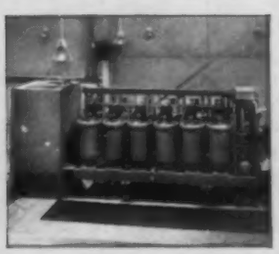

Mercury arc rectifiers furnish variable voltage dc power in support of dc drive motors. They are low cost, high efficiency units providing fast response to control signals, resulting in better voltage control and reduced maintenance.

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METALKASE XP brick, having a single internal plate, are made in hard fired basic brick of various classes. They are available in standard sizes and many special shapes. These brick are used in various particular applications with great benefit.

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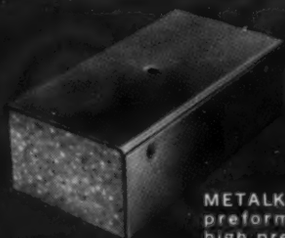
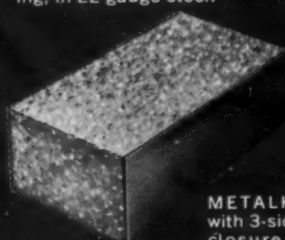


METALKASE brick, preformed under high pressure and encased on all four contact sides by welding, in 22 gauge steel.



METALKASE brick with 3-sided steel enclosure, especially suited for electric furnace side walls and other specific applications.

Other Metalkase designs

HARBISON-WALKER REFRACTORIES COMPANY

AND SUBSIDIARIES **GENERAL OFFICES: PITTSBURGH 22, PENNSYLVANIA**

World's Most Complete Refractories Service

Which advantage is most important to you?

You get them all in WHEELABRATOR® mechanical mill roll etching

? Uniform etch

? Longer roll life

? Better product finish

? Time savings

? Cost reductions

The mechanical and automatic nature of Wheelabrator mill roll etching brings you all of these advantages. For instance, it eliminates the opportunity for human error. Once calibrated, it automatically produces a uniform etch, with optimum penetration, roll after roll. This also means longer roll life — as much as 30% more service life. There are no areas of shallow etch to cause too-frequent dressing and no areas of too-deep etch to cause waste of roll surface in successive etchings. This uniformity also provides more uniform surface finishes on the final product.

Variety in type and size of abrasive, velocity and volume of abrasive, speed of work travel and rotation and other variables are easily adjusted to provide close control of the surface etch. This means a single machine can produce a wide variety of finishes, each meeting a precise surface roughness specification. Time and cost savings come from speed of etching, recently improved by a work car that carries two rolls at once. This not only saves etching time but also reduces mill delay. In addition, changeover for different finishes is faster and re-roll tonnage is reduced because a flatter strip is produced under increased screwdown pressures.

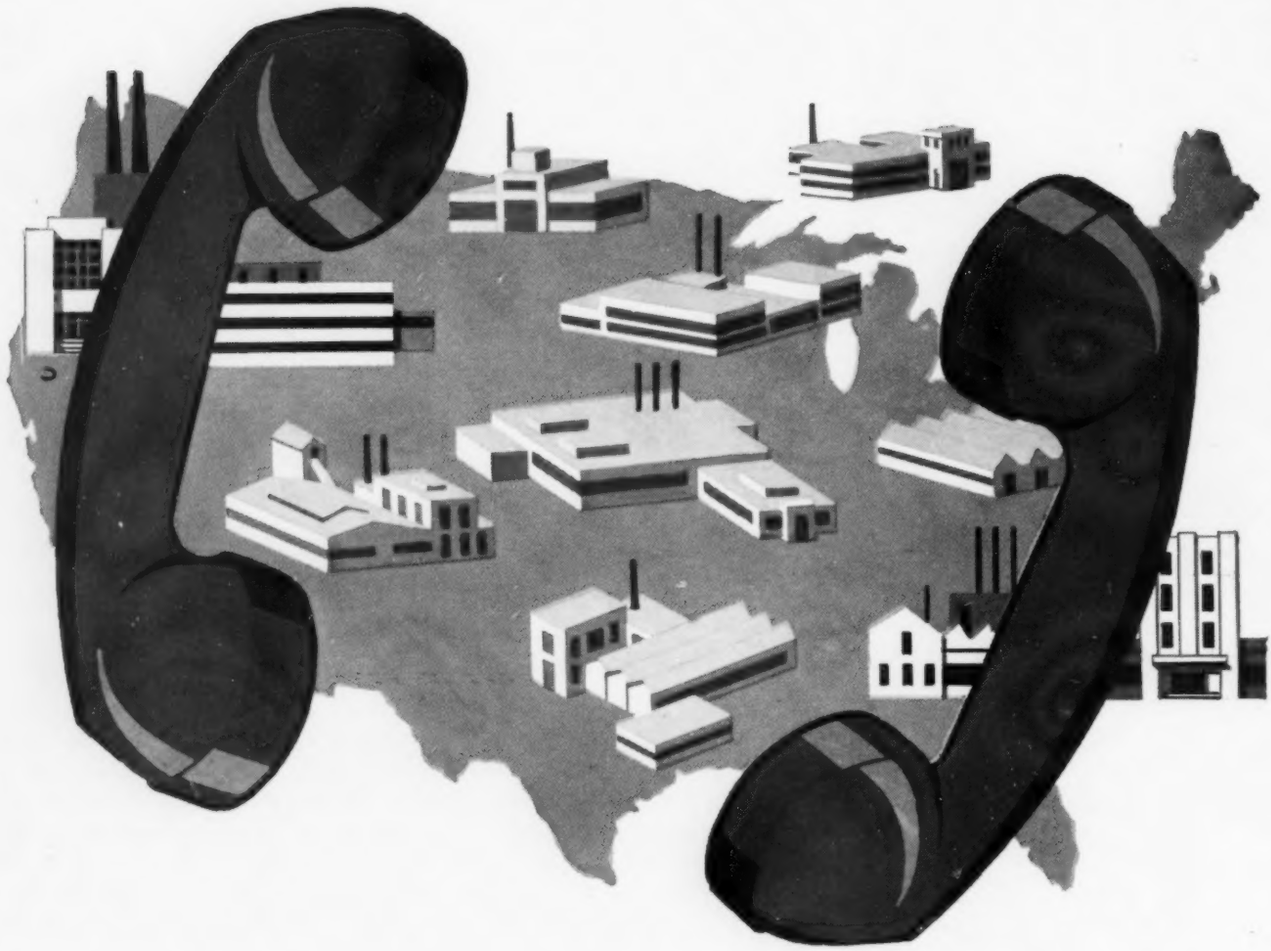
Why not get all of these advantages in your plant for swift, sure mill roll etching?

WHEELABRATOR®
CORPORATION

396 South Byrkit Street — Mishawaka, Indiana

WRITE FOR details on the many new improvements in the Wheelabrator method of etching.

What's causing the swing to that new UNITRODE® nipple?



Its partial pitch impregnation strengthens the electrode joint, improves operating efficiency. We're getting performance data from Great Lakes Carbon!

ELECTRODE GLC® DIVISION

GREAT LAKES CARBON CORPORATION

18 EAST 48TH STREET, NEW YORK 17, N.Y. · OFFICES IN PRINCIPAL CITIES

From coil holder to finished mill product . . . sheet, tin and strip processing is faster, better, through . . .

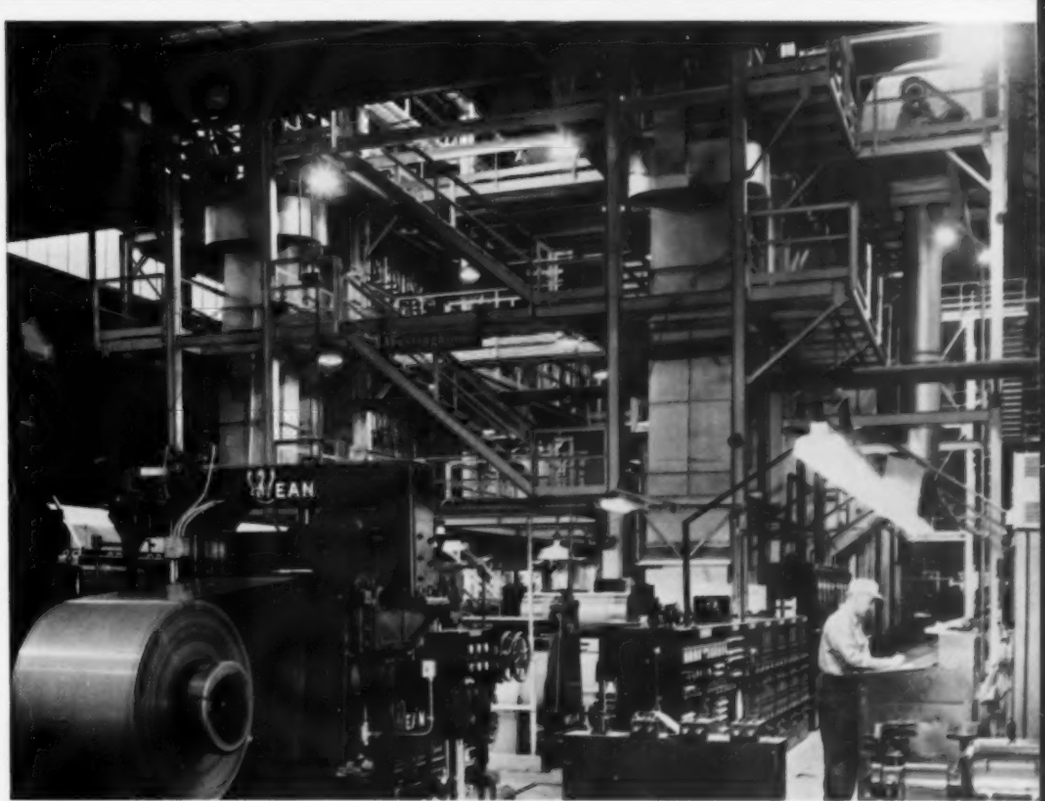
WEAN

CREATIVE ENGINEERING

WEAN Engineered sheet, tin and strip mill installations are at work in virtually every country where steel is produced. Their range and type, — "from coil holder to finished mill product . . ." attest to the comprehensive nature of Wean Creative Engineering.

Wean's planning groups and equipment designers encompass talent and experience unexcelled in the engineering of steel strip processing plant facilities.

Associate Companies have been selected on the basis of proven experience and ability to produce equipment embodying the finest in modern engineering design. On the following pages are presented some of the companies that contribute to Wean Creative Engineering.



Wean Continuous Strip Annealing installation processing silicon strip in U. S. Steel's Vandergrift Plant.

THE WEAN ENGINEERING COMPANY, INC. - WARREN, OHIO

A WEAN ENGINEERING ASSOCIATE COMPANY

Hallden

Wean-Hallden Shear Lines. Most preferred for continuous feed . . . cutting accuracy . . . dependability.

PRECISION engineered and ruggedly constructed, the Hallden Shear has earned a world wide reputation for its unique combination of high speed and cutting accuracy.

Wherever Wean Engineered Sheet, Tin and Strip Mill installations call for shearing of extreme accuracy . . . there is a Wean-Hallden Shear Line maintaining highest production standards. Wean-Hallden Lines are available for hot and cold rolled strip and for a complete range of widths, gauges from ¼" to .0075".

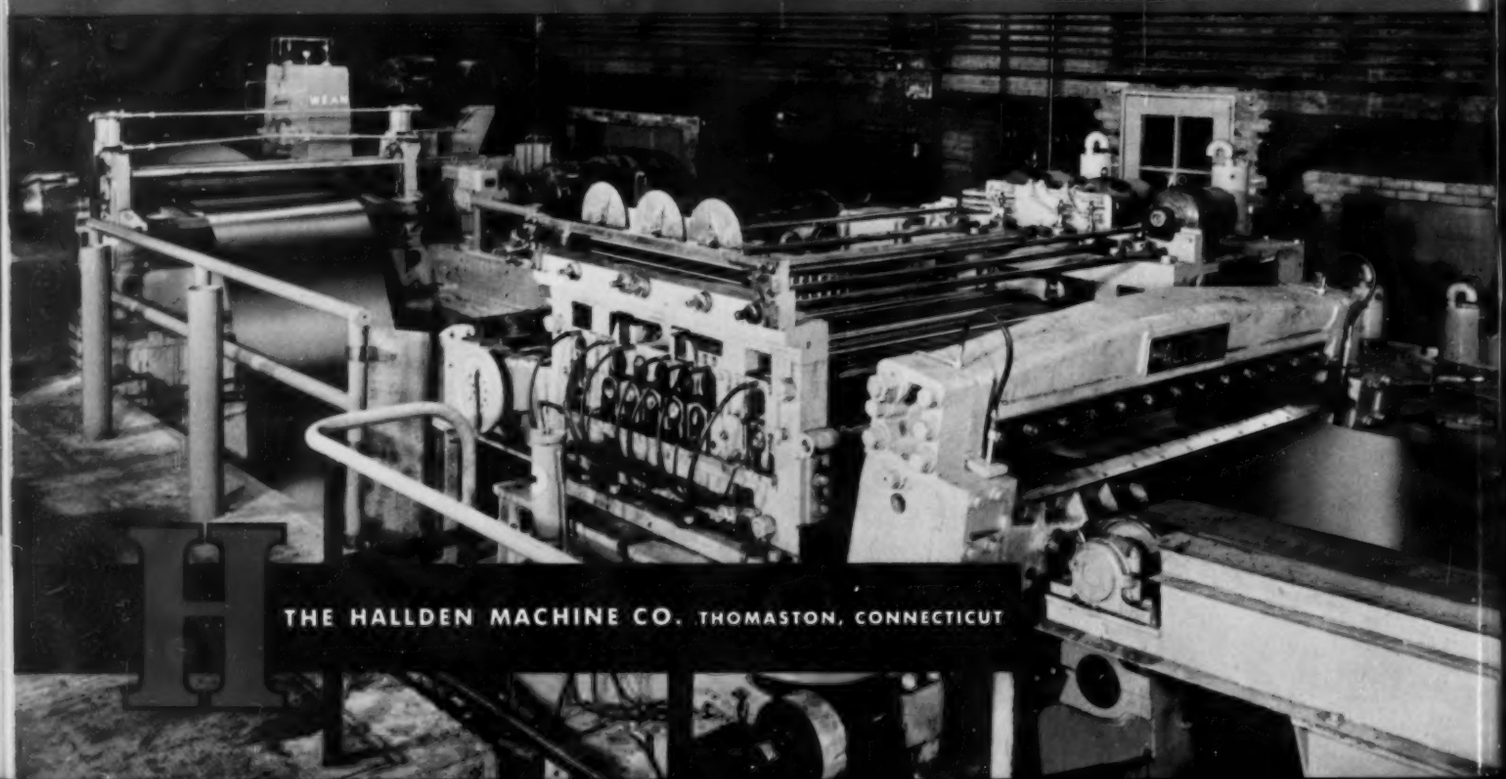
Wean Creative Engineering

sheet, tin and strip mill equipment

PRODUCTS

- Continuous Strip Annealing Lines
- Continuous Strip Pickling Equipment Including:
  - Uncoilers
  - Upcut Shears
  - Stitching Machines
  - Pinch Roll Units
  - Recoilers
  - Drying Machines
  - Pickling Tanks and Auxiliary Equipment
- Electrolytic Tinning and Galvanizing Equipment
- High Speed Strip Flying Shear Lines
- Slitters
- Sheet and Strip Galvanizing Equipment
- Strip Cleaning Lines
- McKay Levelers and Processing Units
- Continuous Strip Coiling Equipment
- Special Conveying Mechanism
- Automatic Pilers
- Uncoiling Units
- Strip Coil Holders
- Strip Coiling Reels
- Strip Uncoiling and Automatic Shearing Units

Hallden Shear in Wean line, operator side, J & L Steel Corporation



THE HALLDEN MACHINE CO. THOMASTON, CONNECTICUT

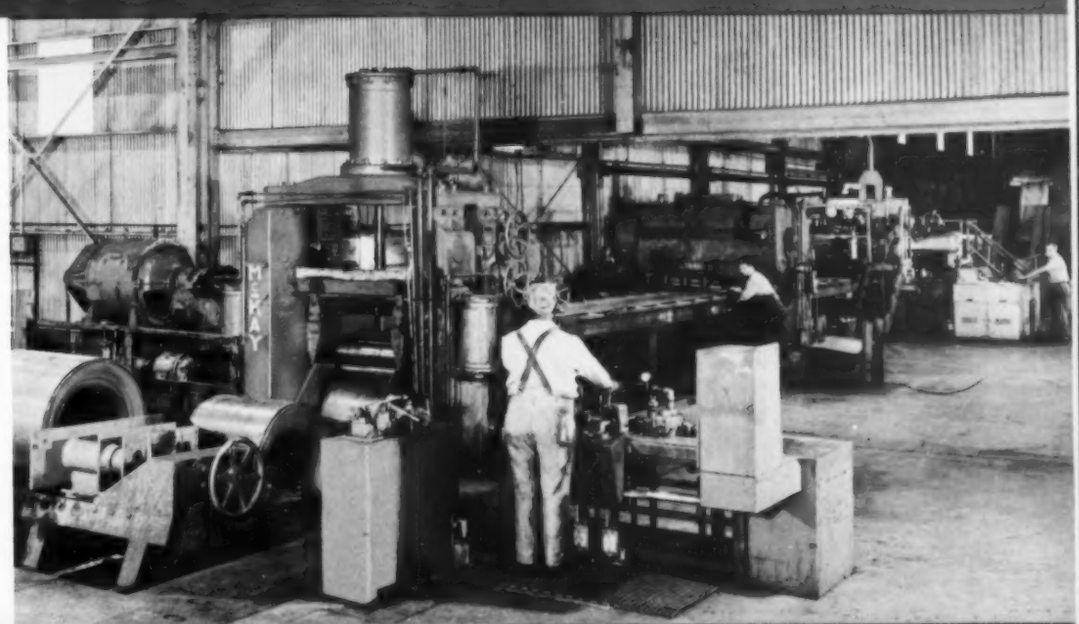
A WEAN ENGINEERING ASSOCIATE COMPANY

McKay

Strip processing uncoilers . . Coil openers, upcoilers . . Roller levelers . . Cold roll forming . . Tube mills . . Draw benches . . Processing machines . . Sheet scrubbers and special steel machinery.

- Automatic Tinning Equipment
- Equipment for Chemically Treating Tin Plate
- Strip Welding Equipment
- Scrubbing, Leveling and Oiling Machines for Flat Products
- Automatic Doublers
- Normalizing Furnaces
- Automatic Feeding and Catching Tables
- Armor Plate Levelers
- Vacuum Cup Lifters
- Sheet Pickling Equipment
- Narrow Strip and Wire Mill Machinery
- Continuous Pack and Pair Heating Furnaces

WEAN ENGINEERING AND ASSOCIATE COMPANIES



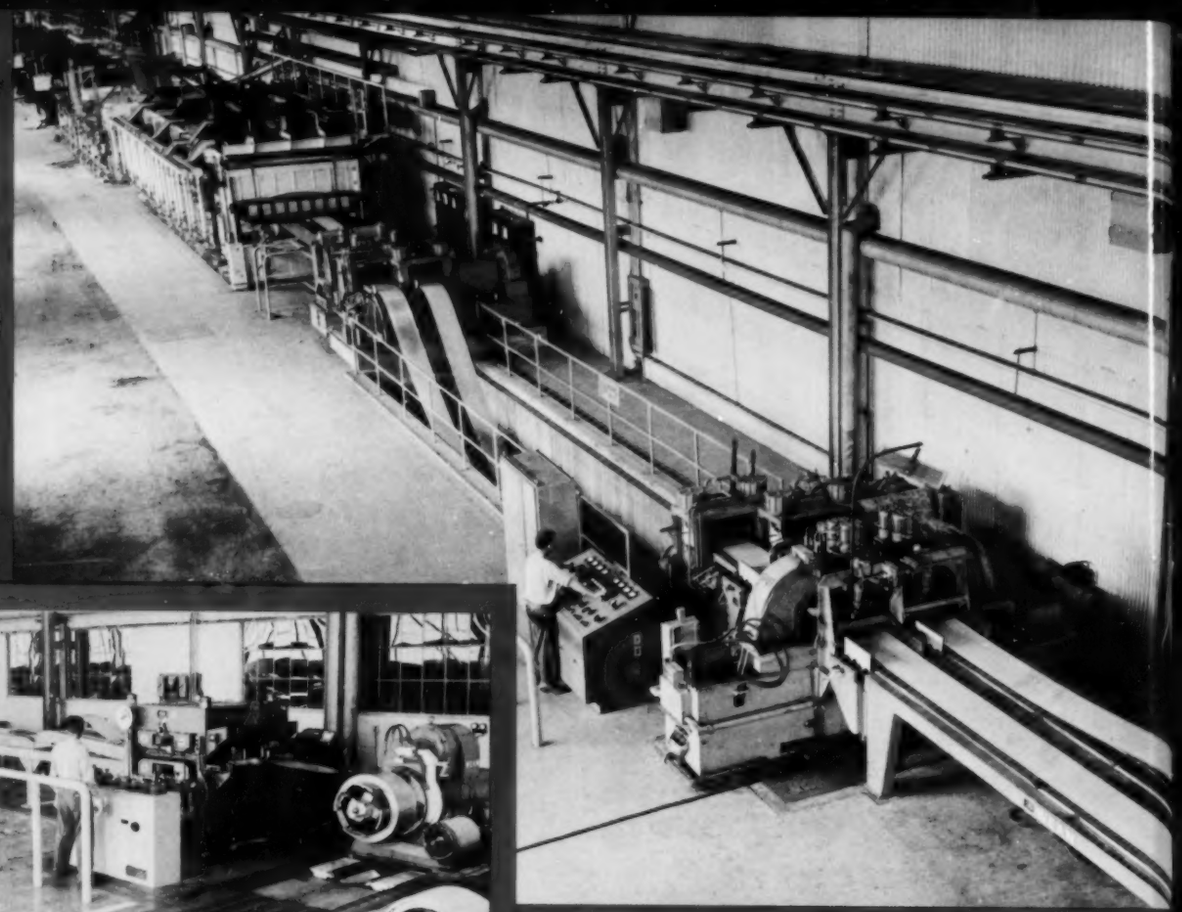
McKay Processing Uncoiler, entry section of strip pickler, Empire Steel Corporation.

THROUGHOUT the steel industry the name McKay is a long established byword for dependability. Wherever steel strip or sheets are processed McKay equipment is recognized for progressive engineering design.

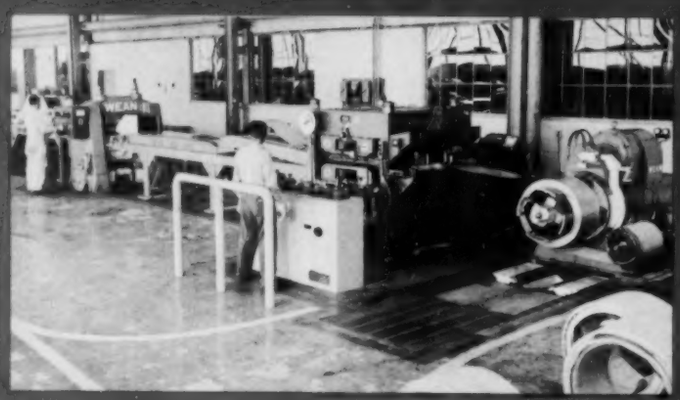
Both standard and special machinery may be designed for integration into complete "push-button" lines.

McK

THE McKAY MACHINE CO. YOUNGSTOWN, OHIO



Entry end of two-strand line for annealing, salt bath descaling and electrolytic pickling of stainless steel.



Entry end: uncut shear line for cold rolled stainless strip. Shear strength: 150,000 p.s.i. max. Yield point: 140,000 p.s.i. max.

A WEAN ENGINEERING ASSOCIATE COMPANY

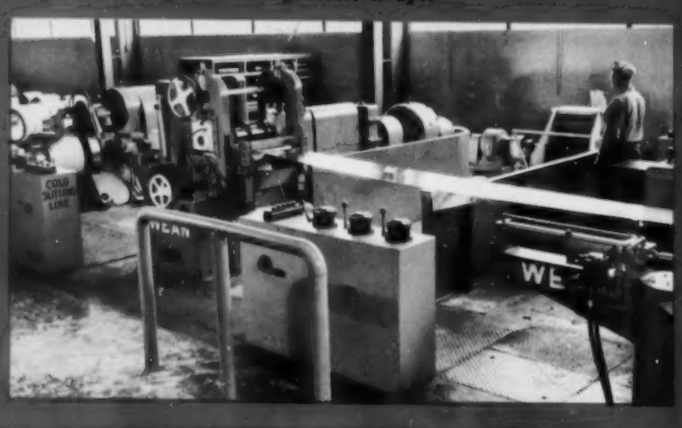
Wean

EQUIPMENT

LONG experienced in the design and construction of complete slitting, shearing, pickling and annealing lines for the stainless steel industry, Wean Equipment has acquired an industry-wide reputation for smoothly functioning, high-production units.

Wean Equipment engineers a broad range of both special and conventional types of auxiliary units to meet virtually every slitting, shearing, pickling and annealing requirement for ferrous and non-ferrous materials.

Exit end: cold slitting line can make 7 cuts of .083 gauge stainless steel. Over-arm separator eliminates need for large disc separators. Paper winder protects wraps.



WEAN EQUIPMENT CORPORATION · CLEVELAND, OHIO

GENERAL ELECTRIC ANNOUNCES

New Totally Enclosed D-c Motors

KINAMATIC* . . . to meet modern needs for faster, more automatic production in severe environments, General Electric announces a complete line of totally enclosed direct-current motors.

Designed for Tough Duty, d-c Kinamatic enclosed motors give you maximum mechanical protection *plus* the wide speed range and versatility required for close control of machines and split-second timing of processes.

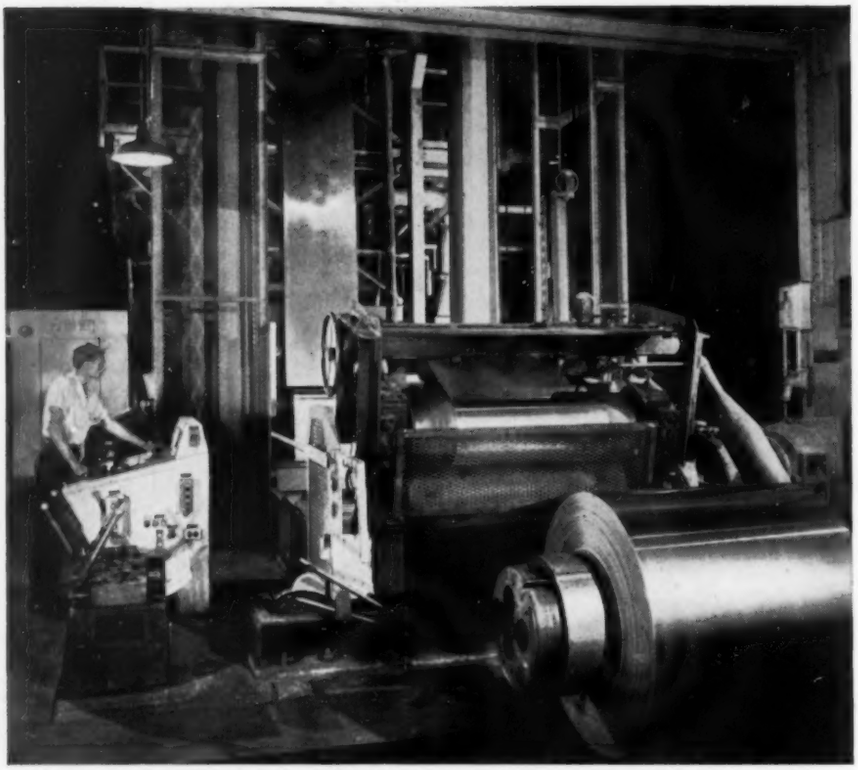
Standard Mounting Dimensions of enclosed d-c Kinamatic motors save you time and money. With this better protected, more powerful direct-current motor, your machines will operate with less down-time . . . faster . . . easier . . . and with less maintenance.

Additional information is available at your nearest General Electric Apparatus Sales Office. Or, if you prefer, write for Bulletin GEC-1372, *Direct Current Motor and Generator Department, Erie, Pennsylvania.* 813-10

*Trade-Mark of the General Electric Company.

Progress Is Our Most Important Product

GENERAL ELECTRIC



Tin plate continuously bright-annealed in direct gas-fired vertical one-pass Selas furnace.

26 Single-Pass Selas Furnaces Heat-Process Strip Continuously . . . at Production Speeds

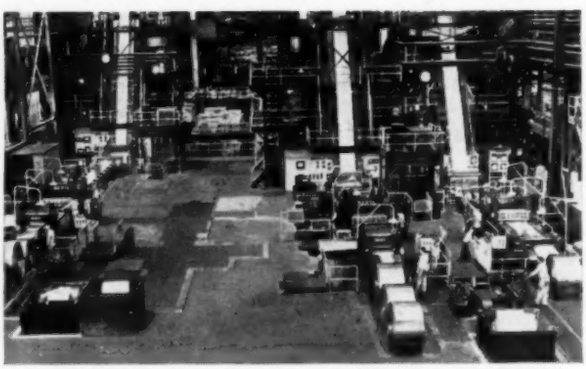
Selas combines Gradiation® Heating with process control to handle a variety of mill operations

Throughout the nation's metal-producing industry, Selas has pioneered, designed and constructed single-pass strip heat-processing lines for bright annealing of steel . . . annealing stainless steel . . . tin reflow . . . galvanizing-annealing . . . preheat for galvanizing . . . preheat for annealing . . . blueing . . . special coatings . . . brass annealing . . .

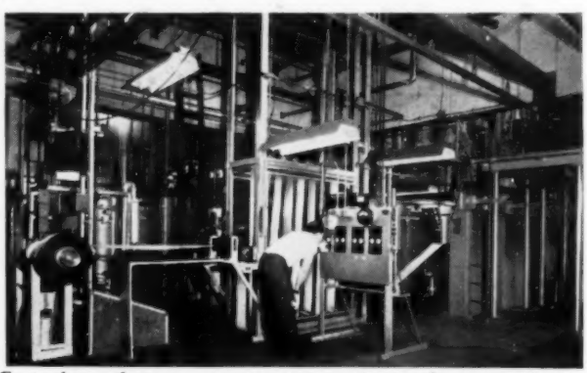
In all these operations, radiant gas heat, precisely applied across the strip width, increases heating speed and produces unsurpassed uniformity in product quality.

- Compact single-pass design saves valuable floor space . . . avoids rolls in heated section, eliminating accompanying maintenance and product quality difficulties.
- Elimination of externally-prepared atmosphere in heating section reduces operating costs.
- Precise thermal control assures reproducible uniformity, regardless of gauge variations.

Technical details of continuous annealing 60 tons per hour tin plate by Selas Gradiation will be discussed in a paper presented to The Combustion Session, Tuesday morning, September 24th, at the annual convention, Iron and Steel Engineers, Pittsburgh.



Annealing and galvanizing strip 48" wide is a high-speed, single-pass, continuous operation with Selas Gradiation heating.



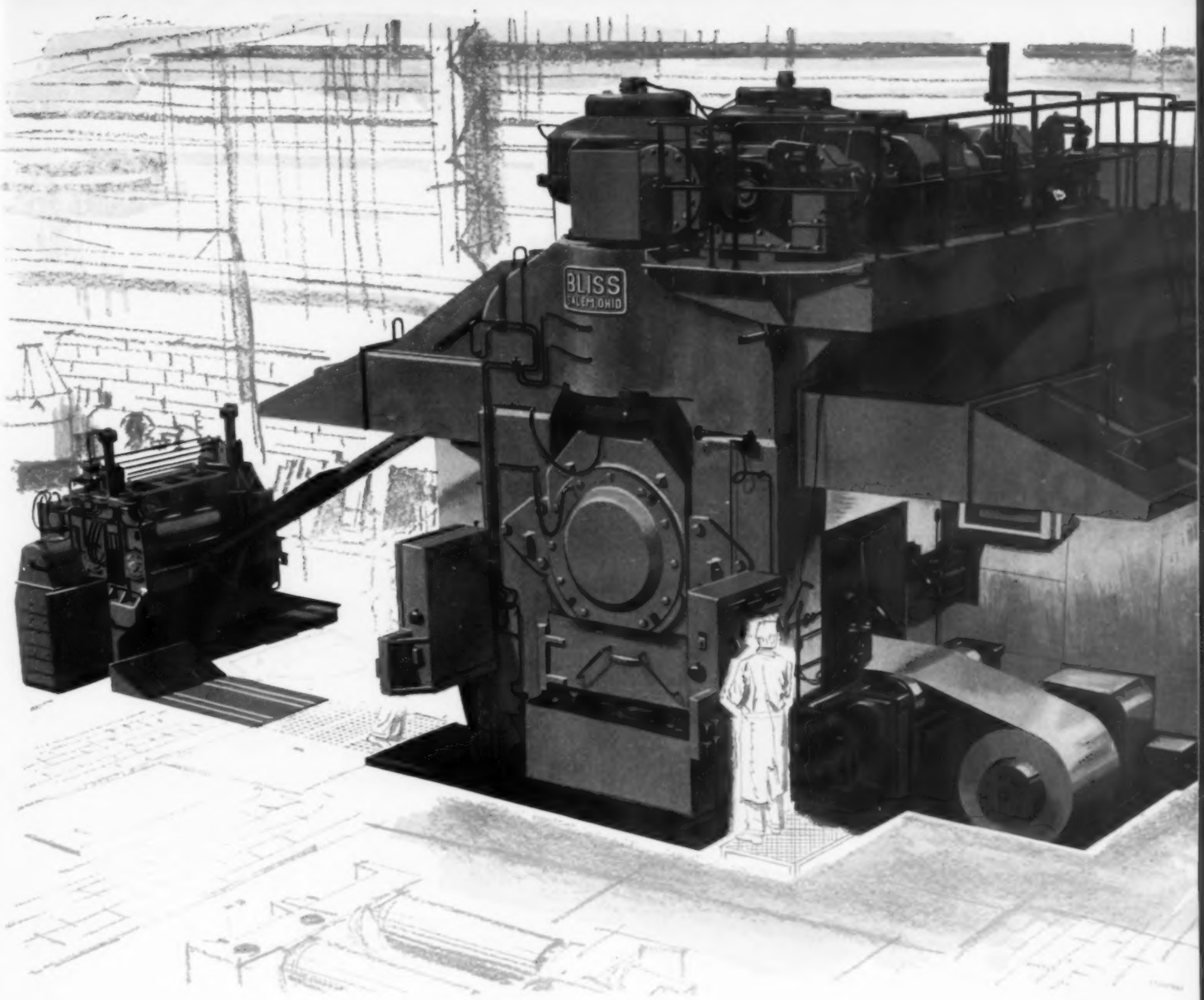
Control panel governs temperature, strip speed, gas combustion and atmosphere composition in this Selas annealing installation.

Our engineers will be glad to discuss how Selas Gradiation methods can be tailored to your strip heat-processing needs. Address Dept. 49, Selas Corporation of America, Dresher, Pa.

SELAS
CORPORATION OF AMERICA
DRESHER, PENNSYLVANIA

Heat and Fluid Processing Engineers

DEVELOPMENT • DESIGN • CONSTRUCTION



Belgian plant comes back to Bliss for another mill

The Phenix Works, Societe Anonyme, of Flemalle-Haute, Belgium, has just installed its second Bliss mill, a big four-high reversing type that will greatly increase the plant's output of cold rolled sheet products.

The mill has 16" and 53" by 48" rolls, a maximum speed of 2000 feet per minute and coil handling equipment for 30,000-pound, 64"-O.D. coils. It is being used to roll both sheet products and tinplate.

Phenix Works put in its first Bliss mill seven years ago. The second installation is the logical outcome of the company's experience with Bliss equipment and engineering... additional evidence that "The Free World rolls on Bliss mills."

Yours for the asking...

For more information on typical Bliss rolling mill installations, write us today for a free copy of our 60-page Rolling Mill Brochure, Catalog 40-A.

BLISS
SINCE 1857

100 years of making metal work for mankind

E. W. BLISS COMPANY, Rolling Mill Division, Salem, Ohio

Subsidiary: The Matteson Equipment Company, Inc., Poland, Ohio

I call KE for plant expansion or new facilities

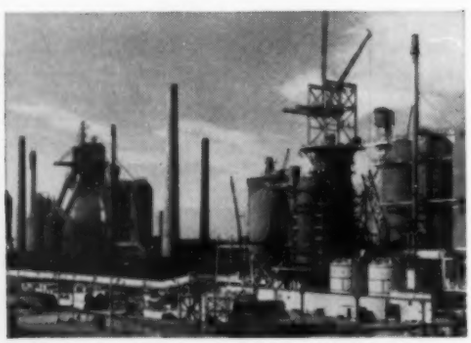
N call KE for plant expansion or new facilities

G call KE for plant expansion or new facilities

E call KE for plant expansion or new facilities

N U I T Y

has made KE a major engineer-contractor serving Steel



At India's mammoth Tata works, at Jones & Laughlin, at Kaiser Steel—Kaiser Engineers' ingenuity advances the art of making steel.

KE can take your development thoughts from a gleam in your eye through start-up. KE performs any part—economic analysis, plant location, engineering, design, procurement, expediting, construction. One contract can cover all.

For your next plant or expansion, take advantage of KE's cost-saving ingenuity and wide experience in Steel.

KAISER ENGINEERS engineers-contractors
Contracting since 1914

Kaiser Engineers Division of Henry J. Kaiser Company • Oakland 12, California • New York, Pittsburgh, Washington, D.C., Buenos Aires, Calcutta, Dusseldorf, Montreal, Sydney, Tokyo

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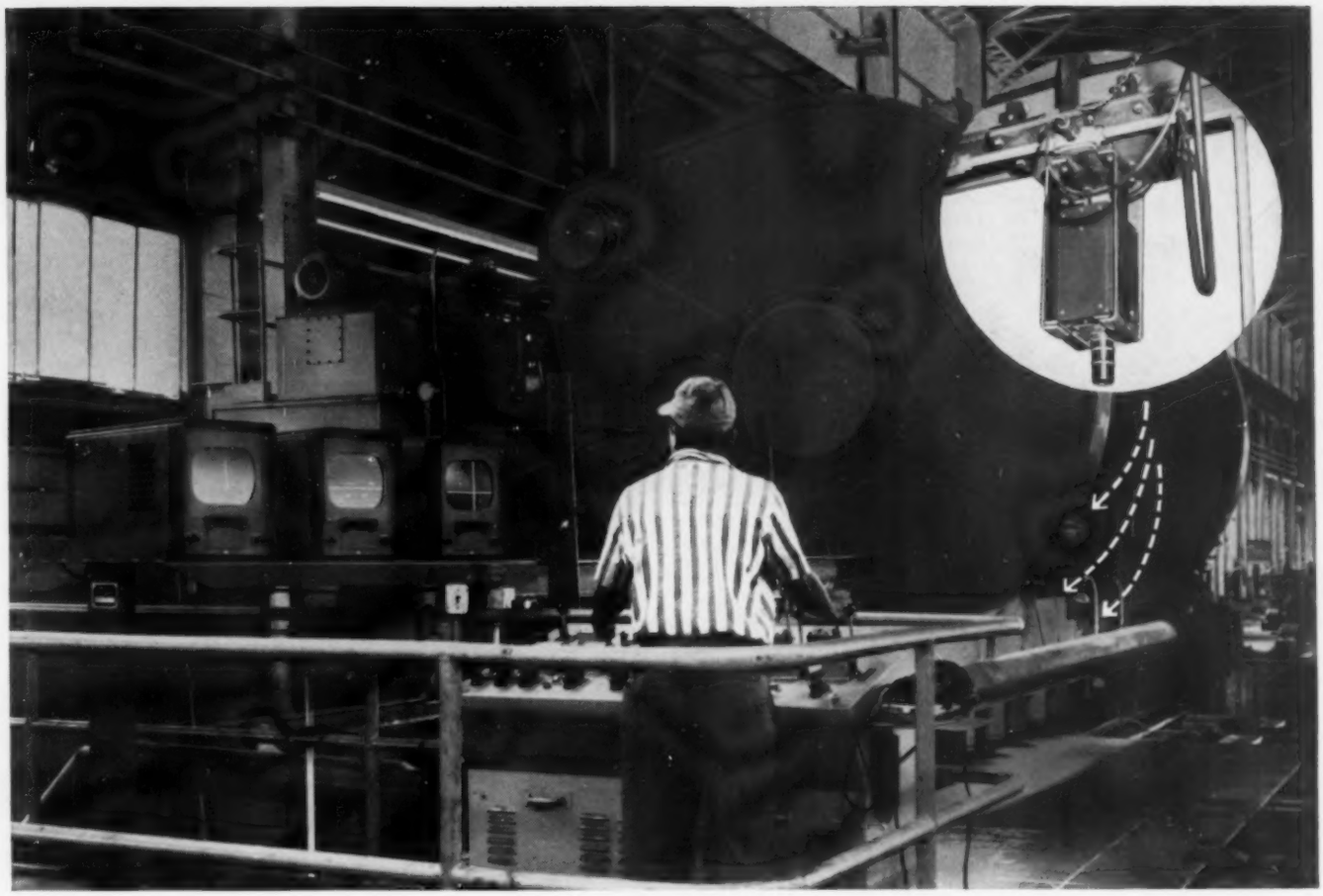

How to see where you can't be ...with RCA Industrial Television!

With RCA Industrial TV to guide him, one man at Lukens Steel Company controls this huge 800-ton plate shear although he cannot see the actual operation! Three RCA TV cameras installed above the blade are connected to three monitors located at the control position. Watching the monitors, the operator moves heavy plate into the shear, lines up the plate with a guide wire, and accurately trims it to size . . . all by remote control!

Wherever it is used, RCA Industrial TV has proved an outstanding factor in personnel safety, increased production, time and material savings. In power plants, factories, laboratories . . . wherever control of vital instruments, processes or materials is required . . . it can be counted on for reliable, accurate performance. RCA Industrial TV is designed and produced to exacting standards by the world leader in electronics.

An RCA representative will gladly help you determine how RCA Closed Television can best serve you. Mail coupon below for free literature.

Mark of RCA *Quality*

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Radio Corporation of America
Broadcast and Television Equipment
Dept. X-188, Building 15-1, Camden, N. J.

☐ Please send me latest literature on the use of RCA Industrial TV (Closed Television).

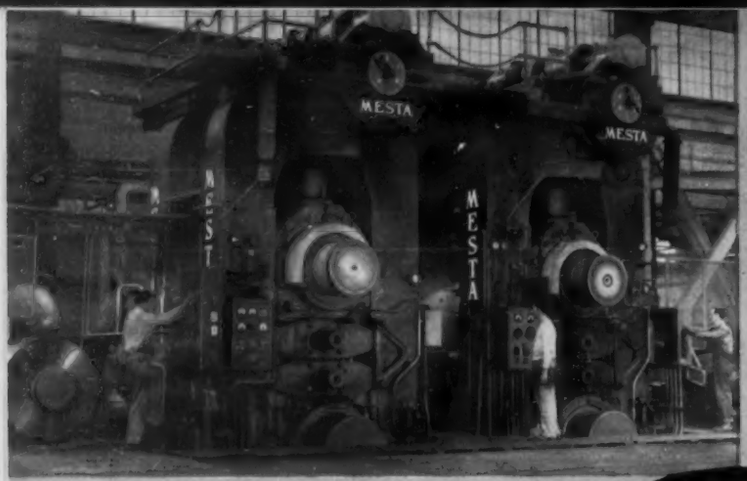
NAME _____ TITLE _____

COMPANY _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____

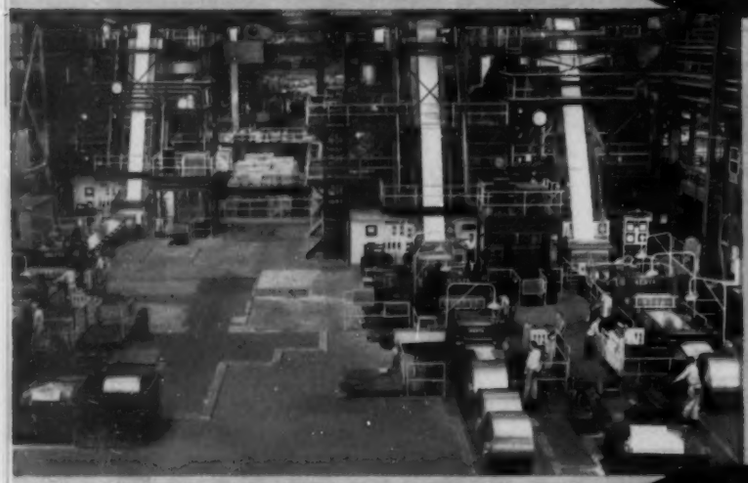
☐ Have representative call.



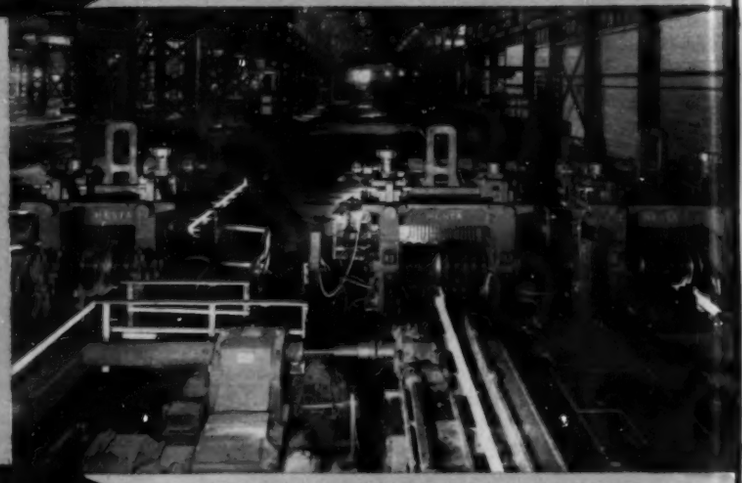
MESTA 42" FOUR-HIGH TWIN-STAND
HIGH-SPEED SKIN PASS MILL

MESTA 60" CONTINUOUS PICKLING LINE WITH FLASH WELDER, TRIMMER AND UP-COILER OPERATING AT INLAND STEEL COMPANY

MESTA

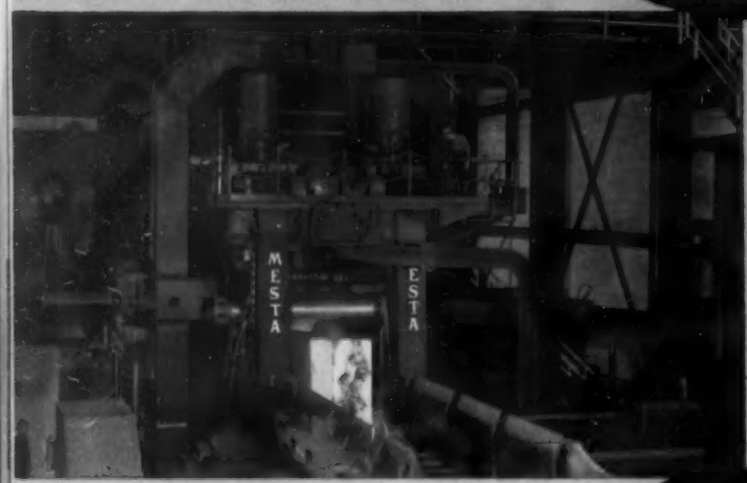


THREE MESTA 48" CONTINUOUS GALVANIZING
LINES WITH AUXILIARY EQUIPMENT



MESTA 32" BAR MILL SHOWING INTERMEDIATE
LEADER AND FINISHING STANDS

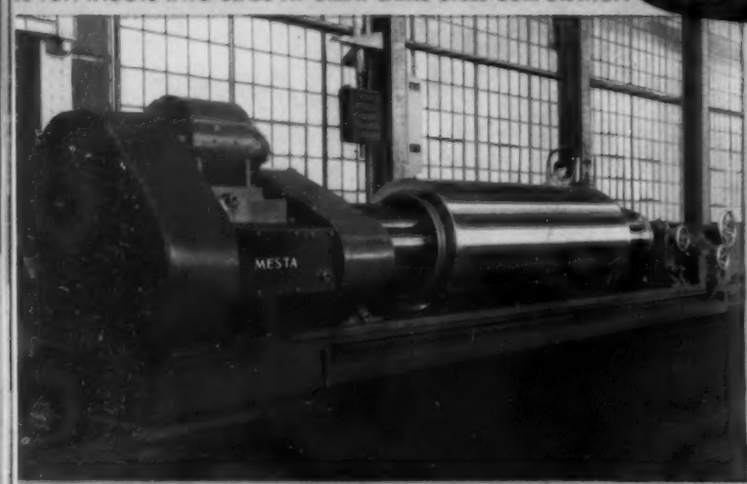
MESTA



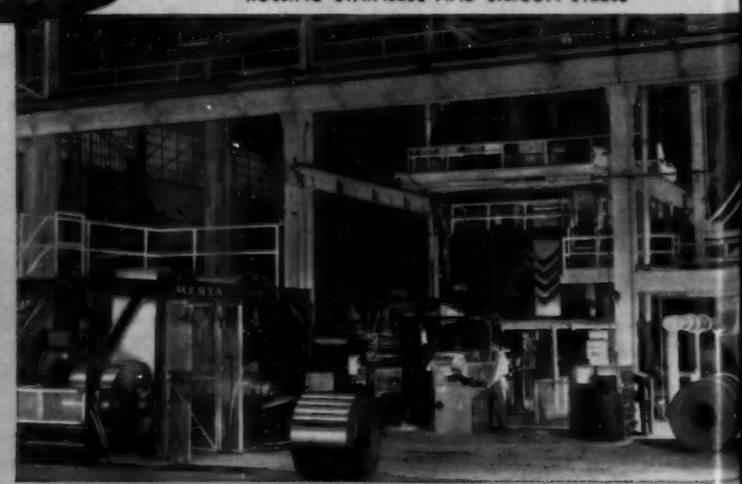
MESTA 45" x 90" UNIVERSAL REVERSING SLABBING MILL ROLLING
20-TON INGOTS INTO SLABS AT GREAT LAKES STEEL CORPORATION

MESTA 56" FOUR-HIGH HOT STRIP MILL FINISHING STANDS
ROLLING STAINLESS AND SILICON STEELS

MESTA

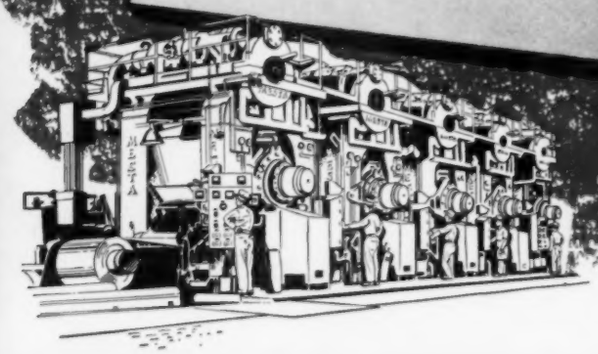


MESTA HEAVY DUTY TRAVELING WHEEL TYPE



MESTA CONTINUOUS STRAINING AND ANNEALING LINE FOR TIN PLATE

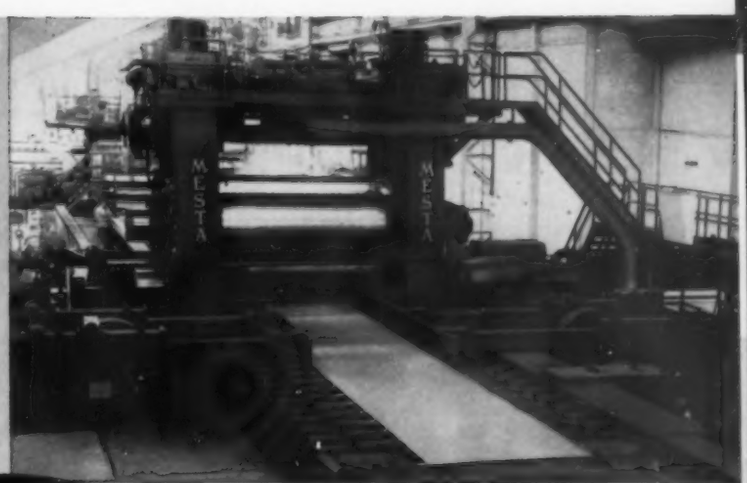
Designed and Built by MESTA



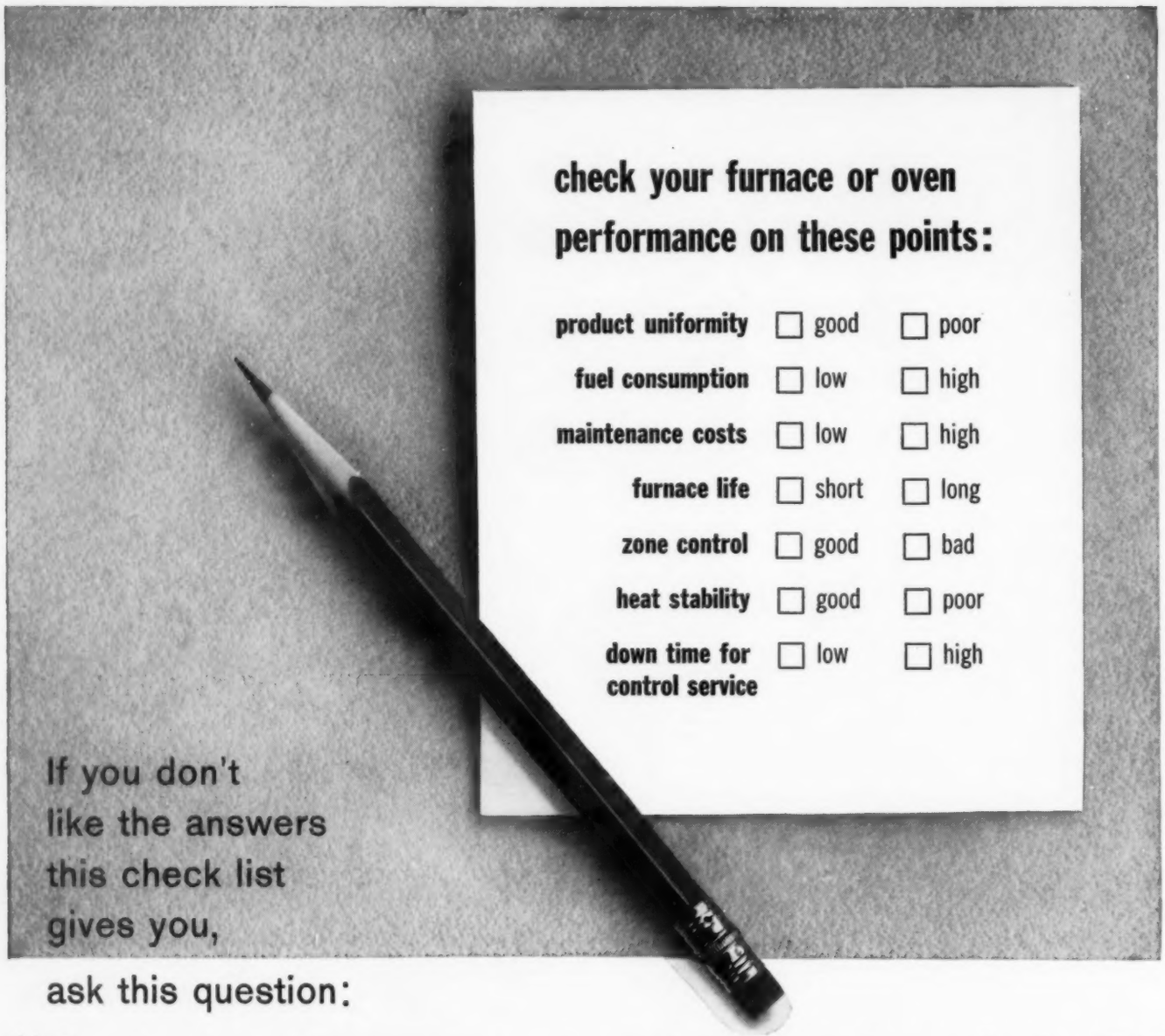
MESTA MACHINE COMPANY
PITTSBURGH, PENNSYLVANIA

MESTA 42" HIGH-SPEED COMBINATION ROTARY FLYING SHEAR AND LEVELLER WITH ROTARY SIDE TRIMMER

MESTA

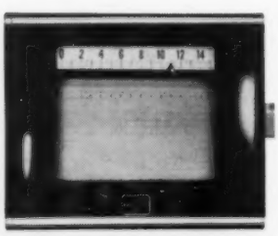


MESTA 132" FOUR-HIGH REVERSING PLATE MILL INSTALLED AT SOCIETE ANONYME COCKERILL-OUGREE, BELGIUM


check your furnace or oven
performance on these points:
product uniformity ☐ good ☐ poor
fuel consumption ☐ low ☐ high
maintenance costs ☐ low ☐ high
furnace life ☐ short ☐ long
zone control ☐ good ☐ bad
heat stability ☐ good ☐ poor
down time for control service ☐ low ☐ high
If you don't like the answers this check list gives you,

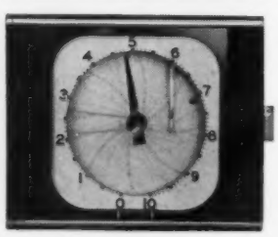
ask this question:

"Are my furnace controls obsolete?"



Strip-chart model

BRISTOL DYNAMASTER* ELECTRONIC PYROMETER CONTROLLERS



Round-chart model

Outmoded instruments can cost you money, lower product quality, and cut output of any furnace or oven.

New Bristol ideas are revolutionizing many older concepts of automatic control. *Bristol's great strides in electronic potentiometer development have made obsolete many instruments only a few years old.*

New product developments and production methods are placing new and unusual demands on furnace instruments and controls today.

That's why it pays to find out about the latest Bristol engineering developments before you buy another instrument or control. Take Continuous Standardization, for example—a feature you'll want on *your* next pyrometer controller. This exclusive Bristol feature, found only on Dynamaster* Pyrometers, eliminates dry cells but retains the accuracy-insuring standard cell. There's no interruption to control for standardization; no batteries to replace.

Continuous Standardization is just *one* recent Bristol development in the field of pyrometry and temperature control. To find out more, write: The Bristol Company, 123 Bristol Road, Waterbury 20, Conn.

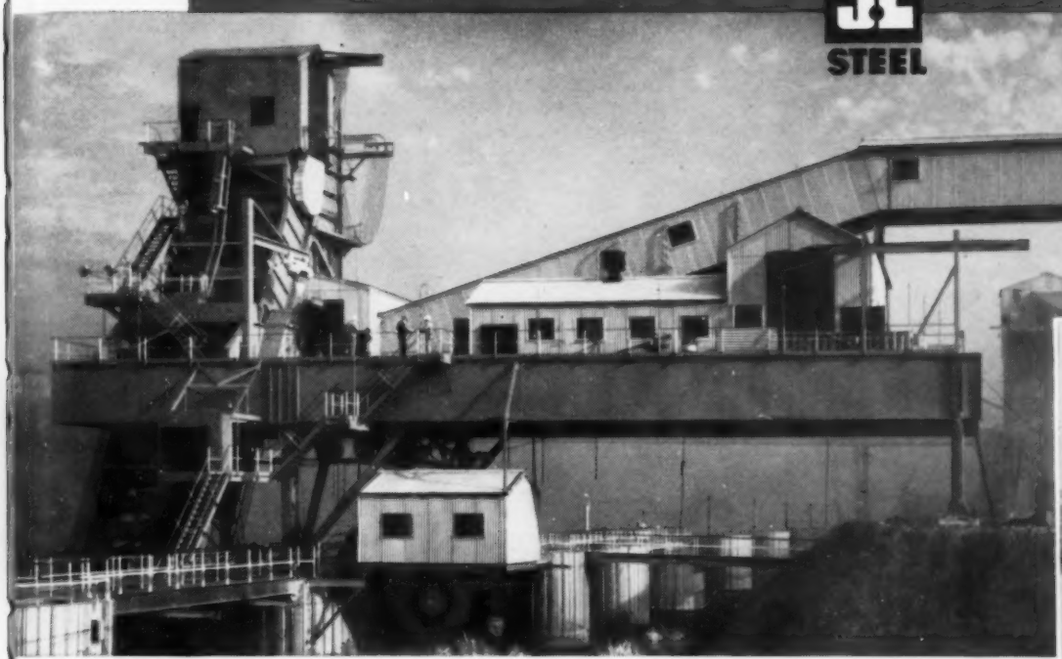
7.16

T. M. Reg. U. S. Pat. Off.

BRISTOL *TRAIL-BLAZERS IN PROCESS AUTOMATION*

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

Another H&P SPEED CHAMPION for J&L STEEL Jones & Laughlin



The new Heyl & Patterson Barge Unloader, coal conveyors and coal bins at the Coal Preparation Plant of the Jones & Laughlin Steel Corp., East Fredericktown, Pa. All movements of the barge and unloader are controlled by one man from the operator's cab. This installation is a virtual duplicate of one operating since 1951 at J & L's Aliquippa Works.

Coal is handled by this Unloader featuring an 83'-long bucket elevator. As the barge is pulled past, each of the continually moving buckets takes a 1400-pound bite from the coal pile and carries it to the top to be discharged on a belt conveyor. The hoist can be raised or lowered 34 feet.

This newest Bucket Elevator Barge Unloader assures low-cost operation at high capacity. It also features the famous built-in H & P reliability.

Heyl & Patterson has built numerous bulk material loading, unloading and handling systems. Whatever your industry . . . coal, steel, chemical, utility, transportation . . . we suggest you call an H & P Sales Engineer to discuss your bulk material handling problems, and remember . . .

When Experience Counts . . .
Count on Heyl & Patterson!

Un-retouched photograph of a barge on its third and final pass indicates the proficiency of the Unloader at cleaning out a barge without damage to it. Because coal is removed so completely, no clean-up men are needed.

70 YEARS OF SERVICE

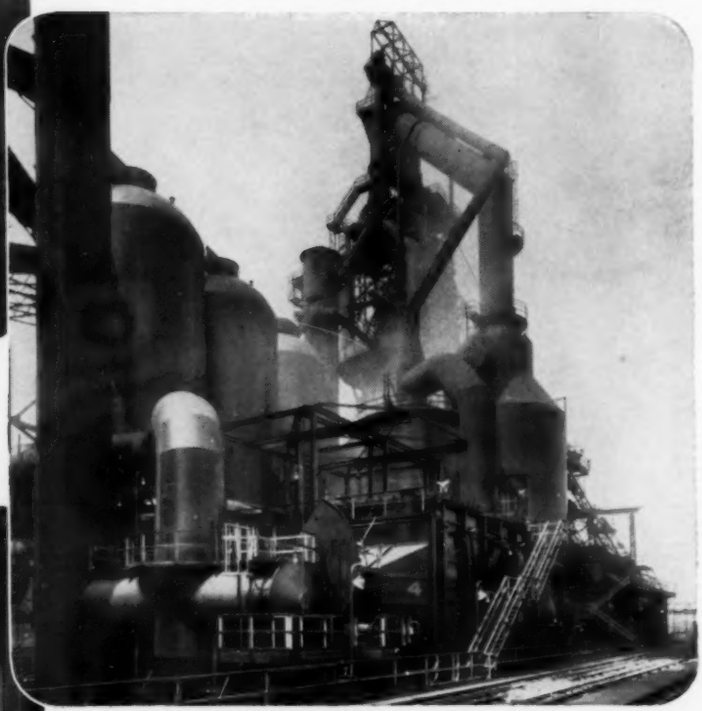
Heyl & Patterson INC.

55 FORT PITT BLVD. • PITTSBURGH 22, PA.

From ore-handling

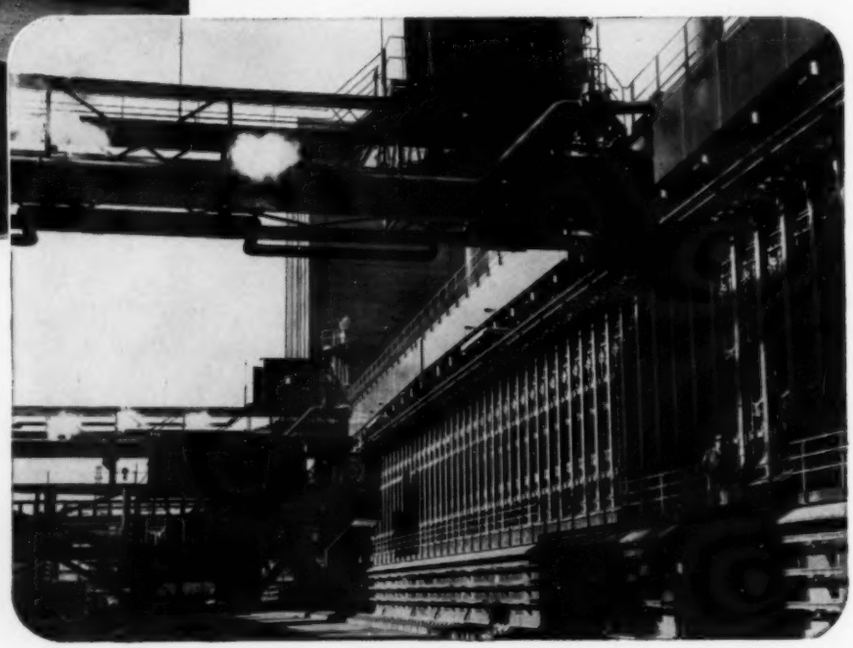
You can put

This ore-handling system was installed by Koppers for Great Lakes Steel Corporation in 1956 to speed up unloading of ore boats. Its capacity is 1,250 tons of ore an hour.



Biggest in the world, "A" blast furnace was designed and erected for Great Lakes Steel Corporation by the Freyn Department of Koppers. It has a hearth diameter of 30 feet, 3 inches . . . a total interior volume of 64,435 cubic feet.

8-foot-wide sintering machine, designed and constructed for Weirton Division of National Steel in 1955. This machine produces over 2,500 net tons of blast-furnace sinter a day. Now, Koppers Freyn Department is building two complete sintering plants—each with a 12-foot-wide machine—for National Steel Corporation.



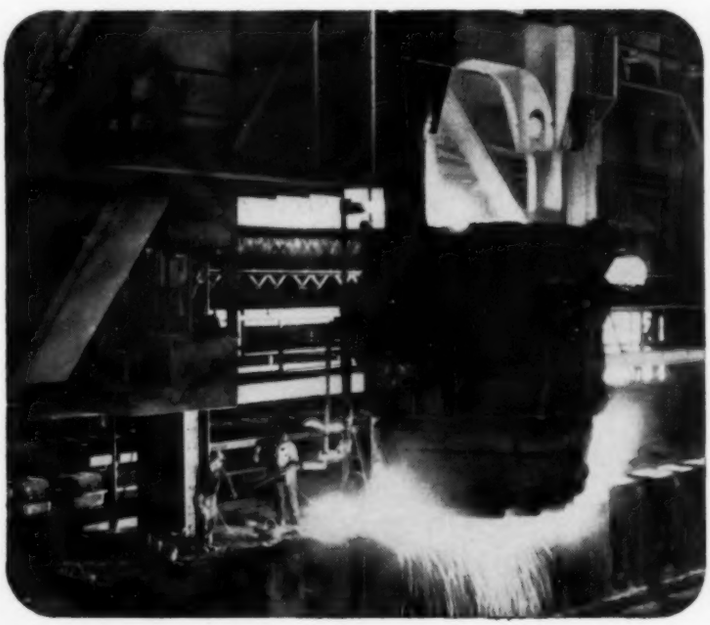
87 Koppers-Becker Coke Ovens, installed by Koppers Coke Plant Department in 1956 for Inland Steel Company's Indiana Harbor Works. This battery carbonizes 1,920 net tons of coal per day and is similar in design to an earlier battery of 65 Koppers Coke Ovens built in 1950.

to finished steel . . .

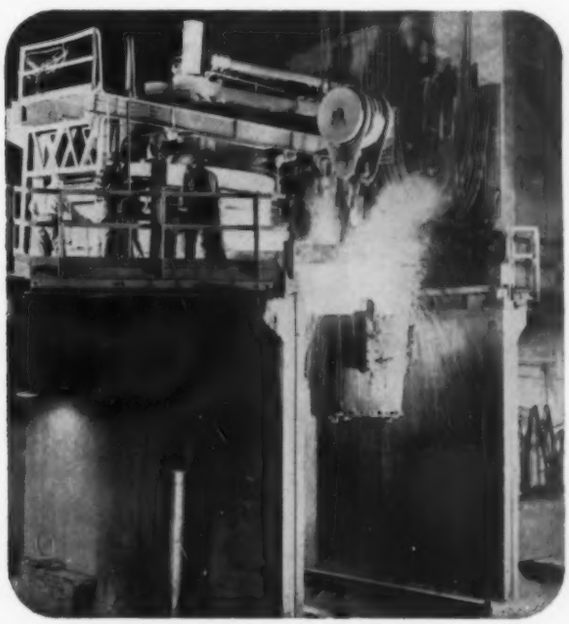
Koppers experience to work in your steel plant

For almost 50 years, Koppers has been designing, engineering and building steel plant installations. Koppers experience covers every step from original planning to final operation of materials handling systems, sintering plants, coke plants, blast furnaces and blast furnace equipment, open-hearth, electric-furnace and converter shops, rolling mill shops, and gas cleaning installations.

Put this experience and proved ability to work for your company. Call on Koppers next time *you* plan to build . . . rebuild . . . or expand. Koppers Company, Inc., Engineering and Construction Division, Pittsburgh 19, Pa.



This open-hearth shop, with eight furnaces, was designed and engineered for Youngstown Sheet & Tube Company by the Freyn Department of Koppers. Rated annual ingot capacity of the furnaces is 1,776,000 net tons. Koppers also designed a complete slabbing mill for this same company.

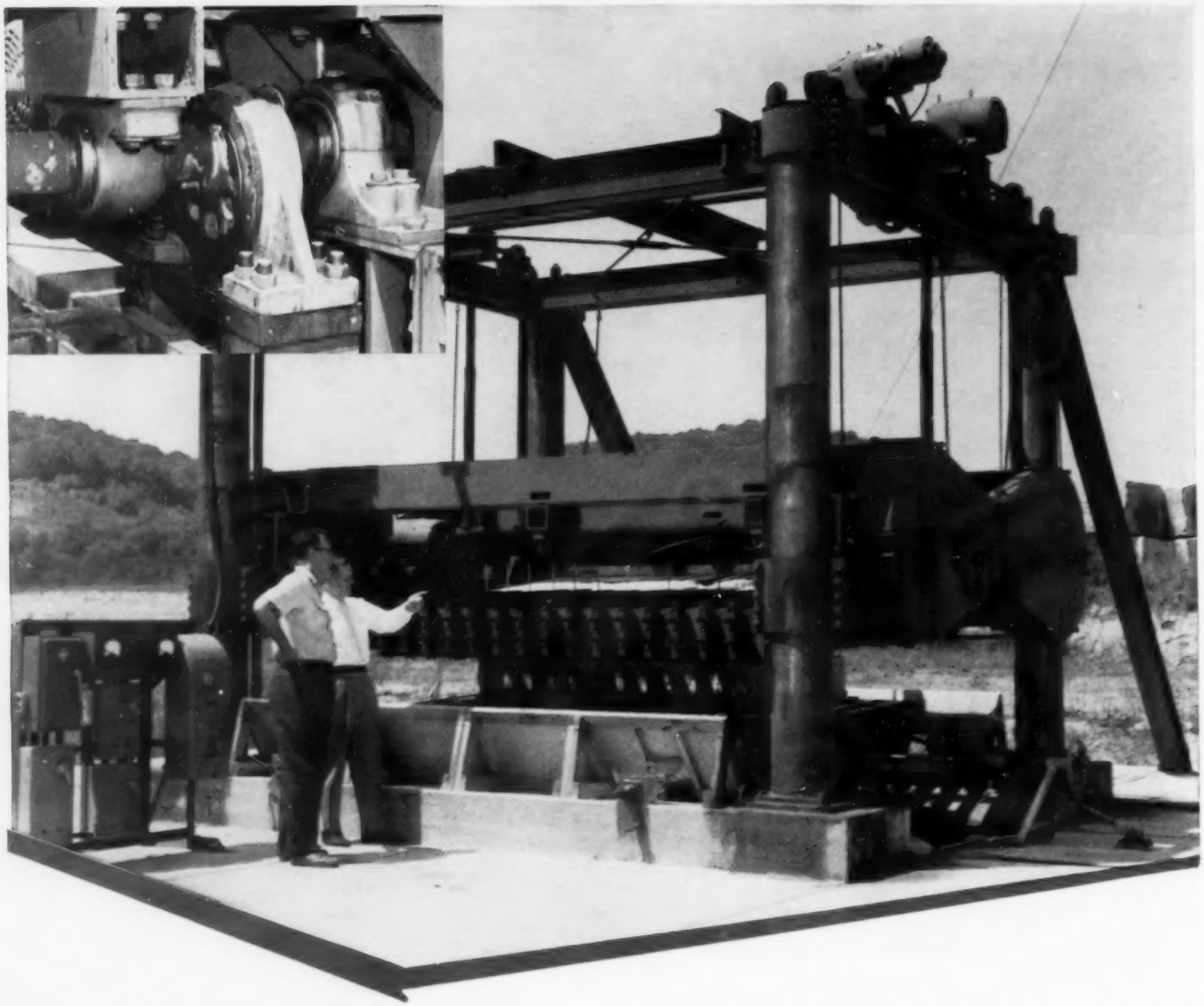


Electric-furnace shop, engineered and built in 1952 by Koppers Freyn Department to produce stainless and specialty steels for Allegheny Ludlum Steel Corporation at Watervliet, New York.

KOPPERS

KOPPERS

ENGINEERING AND CONSTRUCTION



Bearings, Inc. helps engineer first change in stone sawing since the year 1.

It took over 1957 years to bring about a basic change in stone saws! A Bearings, Inc. service engineer helped this customer, a stone company in Central Ohio, make this change for more accurate, high-speed stone sawing. Previously, stone "sawing" had actually been a process of grinding stone away with the help of abrasives.

Now, an eccentric bearing (shown above) specially designed by our engineers accurately controls movement of the blades into the work and with the use of carboloy tools on the blades, *stone is now actually cut for the first time.* No abrasives are required and cutting speeds are many times faster than with the old method.

You may not have a stone cutting problem but if your problem involves bearings . . . get the competent services of bearing experts who sell and service the best nationally known lines of bearings and accessories. Call the stock carrying branch nearest you now!

Providing bearing service in the territories adjacent to our branches, listed below.

BEARINGS, INC.

OHIO: Akron • Canton • Cincinnati • Cleveland • Columbus • Dayton • Elyria • Hamilton • Lima • Mansfield • Toledo • Youngstown • Zanesville
INDIANA: Ft. Wayne • Indianapolis • Muncie • Terre Haute
PENNSYLVANIA: Erie • Johnstown • Philadelphia • Pittsburgh • York
WEST VIRGINIA: Charleston • Huntington • Parkersburg • Wheeling
NEW JERSEY: Camden • **MARYLAND:** Baltimore
DELAWARE: Wilmington •
Subsidiaries: Balanrol Corp. • Buffalo, N.Y.•
In the South • Dixie Bearings, Inc.

NEW! HOLOPHANE HIBAY* REFLECTOR

for Mercury Vapor Lamps

*®

Designed specifically for

STEEL MILLS

No. 641 for 400 Watts
No. 643 for 1000 Watts

Another important contribution to effective industrial lighting developed by HOLOPHANE Research—a new HIBAY REFLECTOR for 400 Watt or 1000 Watt Mercury Vapor Lamps . . . Advantages: • Prismatic reflector provides highest lighting efficiency from heights of 30 feet or more • glare is eliminated by proper shielding angle • sealed metal cover keeps reflector clean, secures unit against mechanical or thermal shock • new drip cover protects lamp and reflector from moisture, condensation, seepage • low operating and maintenance costs . . .

Write for Engineering Data

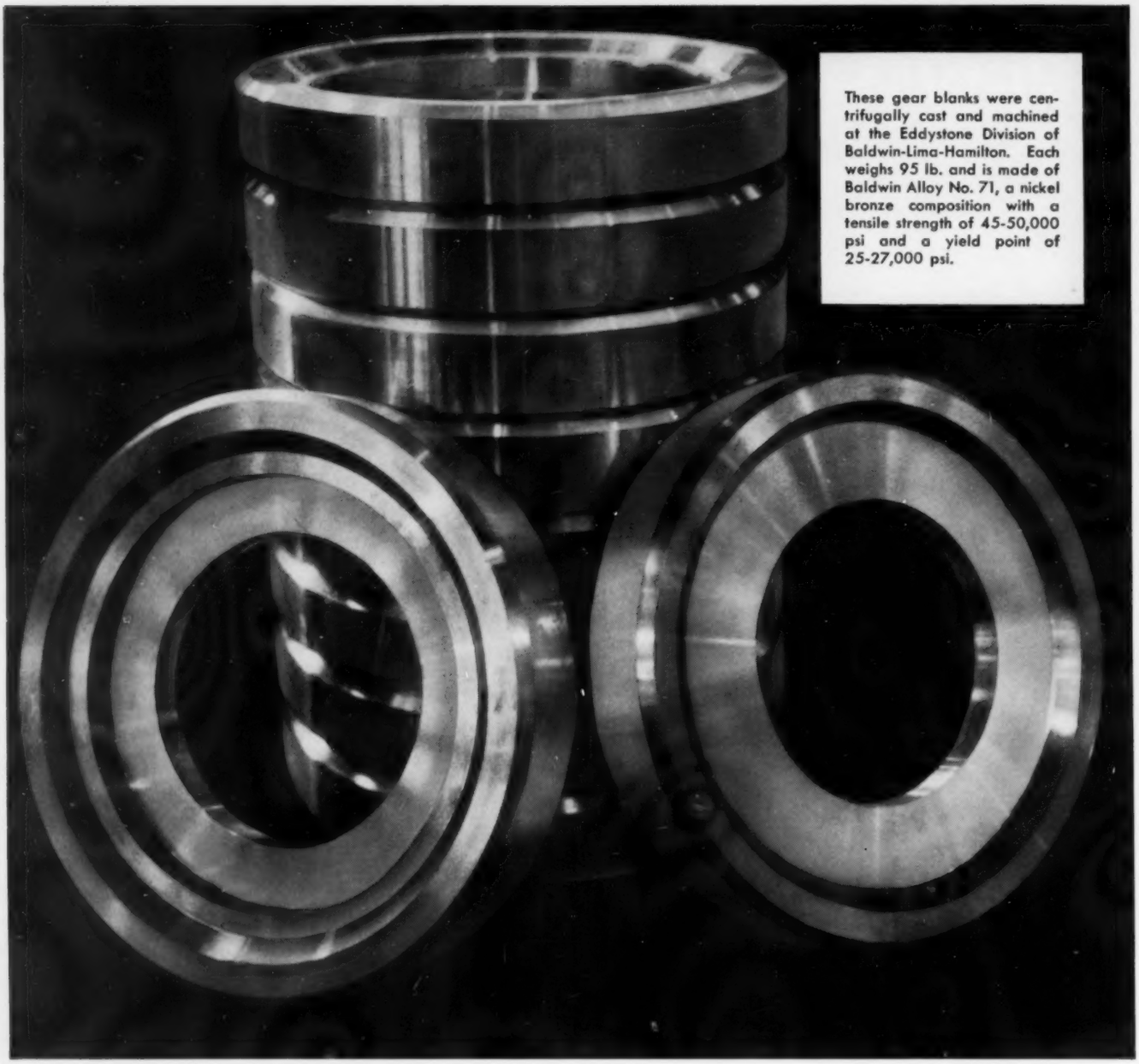
To be sure of Quality in Lighting . . . look for the name HOLOPHANE impressed on each piece.

HOLOPHANE

COMPANY, INC. • ***Lighting Authorities Since 1898***

342 Madison Ave., New York 17, N. Y.

THE HOLOPHANE CO., LTD., 418 KIPLING AVE. SO., TORONTO 14, ONTARIO



These gear blanks were centrifugally cast and machined at the Eddystone Division of Baldwin-Lima-Hamilton. Each weighs 95 lb. and is made of Baldwin Alloy No. 71, a nickel bronze composition with a tensile strength of 45-50,000 psi and a yield point of 25-27,000 psi.

Though finish-machined to point of hobbing and drilling, these Baldwin centrifugally cast worm gear blanks **cost no more than rough castings**

When you need a production run of centrifugal castings weighing more than 50 lb. each, Baldwin will cast and finish-machine them to the point of hobbing and drilling, yet charge you no more than for rough castings. And finish-machined gears, since they are so much lighter than rough castings, afford you a substantial saving in shipping expenses. Further, by having Baldwin machine them, you eliminate the possibility of receiving defective gears, for any flaws they might have would be uncovered in the machining operation.

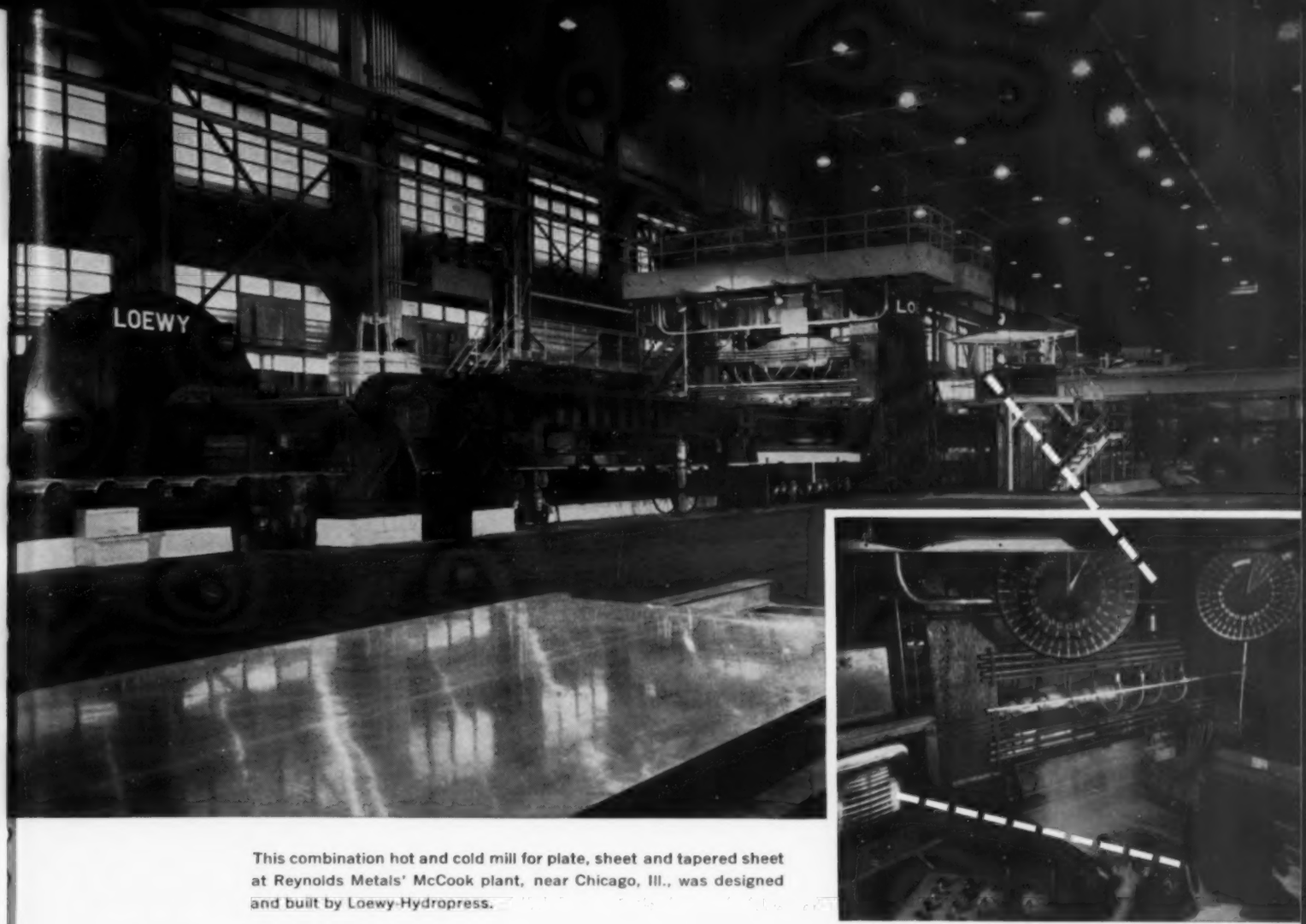
Centrifugal castings are stronger and more durable. The next time you require them, be sure to consult us. We manufacture centrifugally cast blanks in all sizes up to 78 in. in diameter. Write us today for further information. And remember, B-L-H is an excellent source for *all* your foundry needs.

BALDWIN · LIMA · HAMILTON

Eddystone Division

Philadelphia 42, Pa.

Hydraulic turbines • Weldments • Dump cars • Nonferrous castings



This combination hot and cold mill for plate, sheet and tapered sheet at Reynolds Metals' McCook plant, near Chicago, Ill., was designed and built by Loewy-Hydropress.

Control Station features TV observation.

AT REYNOLDS METALS . . .

Country's largest combination breakdown and plate rolling mill produces finished aluminum plate down to .032 in. thickness

Designed and built by Loewy-Hydropress, this Navy rolling mill—largest installation of its kind in America—permits, in addition to the rolling of thick plate, the hot and cold rolling of aluminum alloy tapered plate and sheet so vital to supersonic speed aircraft.

Cast or prerolled solid ingots or prerolled clad ingots are fed into the four-high mill, which can produce aluminum plate *up to 135 in. wide.* Automatic electronic controls and cold rolling under tension allow sheet and plate to be rolled to precision tapered thicknesses down to .032 in. (cold), with a maximum taper of .25 in. per ft. and a maximum length of 480 in. For hot taper rolling, this length can be considerably increased. Here is evidence of Loewy's creativity in rolling mill engineering.

To individual production requirements, Loewy-Hydropress designs, builds and installs hot and cold rolling mills for ferrous and nonferrous metals; continuous merchant and wire-rod mills; skelp mills; two-high and three-high blooming mills; high speed foil mills; continuous billet and sheet-bar mills; strip, slabbing, plate, structural, rail mills; and special mills. For further information, write us today, Dept. C-9.

Loewy-Hydropress Division

BALDWIN · LIMA · HAMILTON

111 FIFTH AVENUE, NEW YORK 3, N.Y. Rolling mills • Hydraulic machinery • Industrial engineering

BALDWIN BLH LIMA-HAMILTON

Now you can buy a

Bailey-built HEAT PROVER Analyzer

CONTINUOUS READINGS OF OXYGEN AND COMBUSTIBLES

The famous Cities Service HEAT PROVER Analyzer, formerly available only on loan, is now manufactured by Bailey Meter Company, and you can buy one outright. With this handy portable instrument, you can easily monitor the per cent of oxygen and combustibles in gases.

The continuous readings from a Bailey HEAT PROVER Analyzer enable furnace, kiln, and engine operators to correct combustion variables before costly losses are incurred. Although it weighs a scant 25 pounds, the HEAT PROVER Analyzer is the key to maximum combustion efficiency. With it, the operator can determine the proper proportion of fuel to air at any time.

The two meters on the analyzer show per cent by volume of oxygen and combustibles on either a 20% range span or a more sensitive 4% range. Temperature of flue gases in degrees Fahrenheit is also shown.

Compared with involved, time-consuming Orsat measurements of flue gases, this new portable analyzer offers these advantages:

1. Simultaneous direct readings of oxygen and combustibles.
2. Negligible time lag between combustion change and reading change.
3. Continuous sampling, analysis, and readings.
4. Convenient measurement of temperature.

Ask your Bailey engineer how you can use this instrument to increase combustion efficiency. Or, write today for more information on how this new Bailey HEAT PROVER Analyzer can pay for itself practically at once. G-39-1

Flue gas analysis with a Bailey HEAT PROVER Analyzer at a furnace stack. Per cent oxygen and combustibles is shown continuously.

Instruments and controls for power and process

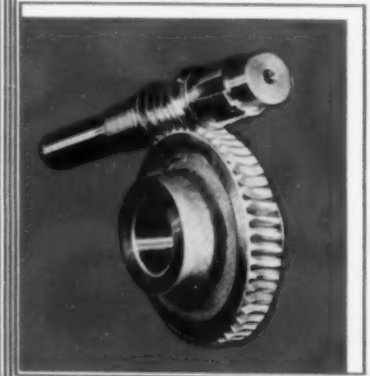
BAILEY METER COMPANY

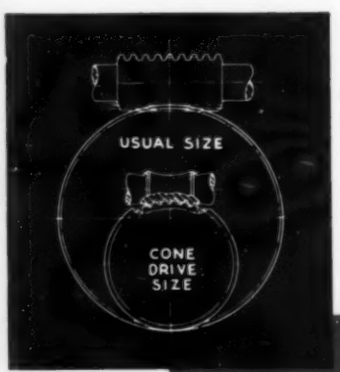
1047 IVANHOE ROAD • CLEVELAND 10, OHIO

In Canada—Bailey Meter Company Limited, Montreal

BAILEY METERS

if you're looking for concentrated power





. . . CONE-DRIVE gearing has no equal.

You can pass an amazing amount of power through a set of Cone-Drive gears.

Want to cut product size? Cone-Drive will give you a more compact gear train with reserve load capacity.

Want to boost power output and hold size? That's easy with Cone-Drive gears. They'll carry two, three, and four times the load of cylindrical worm gearing.

Why? In Cone-Drive gears, the load isn't concentrated on a small area per tooth or on just one or two teeth at a time. Cone-Drive's exclusive double-enveloping principle distributes the load over a lot of teeth and over more area on each tooth.

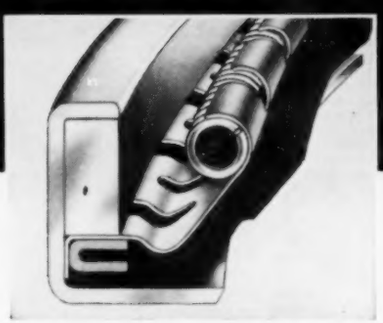
It cuts the unit loading the same way a pair of snowshoes supports a heavy man.

Ask for Bulletin CD-400 for complete details.

CONE-DRIVE GEARS
Division, Michigan Tool Company
DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS
7171 E. McNichols Road • Detroit 12, Michigan

YOUNGSTOWN Equips Hot Strip Mills with Garlock KLOZURE* Oil Seals . . . SAVES OIL and MAINTENANCE TIME

Photo shows roll bearing in foreground with KLOZURE Oil Seal and retainer ring removed. In background a new KLOZURE Oil Seal is quickly inserted in retainer ring.



Cross section of Model 64 KLOZURE Oil Seals used on back-up rolls of steel mills.

Nine back-up rolls on the Hot Strip Mill illustrated have been equipped by Youngstown Sheet & Tube Company with 72 Garlock KLOZURE Oil Seals. The rolls run at speeds of 1025 ft. per min. Oil pressure is approximately 8 psi. at temperatures to 120° F.

Youngstown is able to roll a half a million tons of steel on this Mill before the KLOZURE Oil Seals need replacement. Furthermore, considerable maintenance time is saved when replacement seals are applied.

Also, a large percentage of oil has been saved due to the application of Garlock KLOZURE Oil Seals.

If you have an application that requires oil seals, why not investigate the advantages of KLOZURE Oil Seals. They are another important part of "the Garlock 2,000" . . . two thousand different styles of packings, gaskets, and seals for every need. It's the only complete line . . . that's why you get unbiased recommendations from your Garlock representative. Call him or write for KLOZURE Catalog.

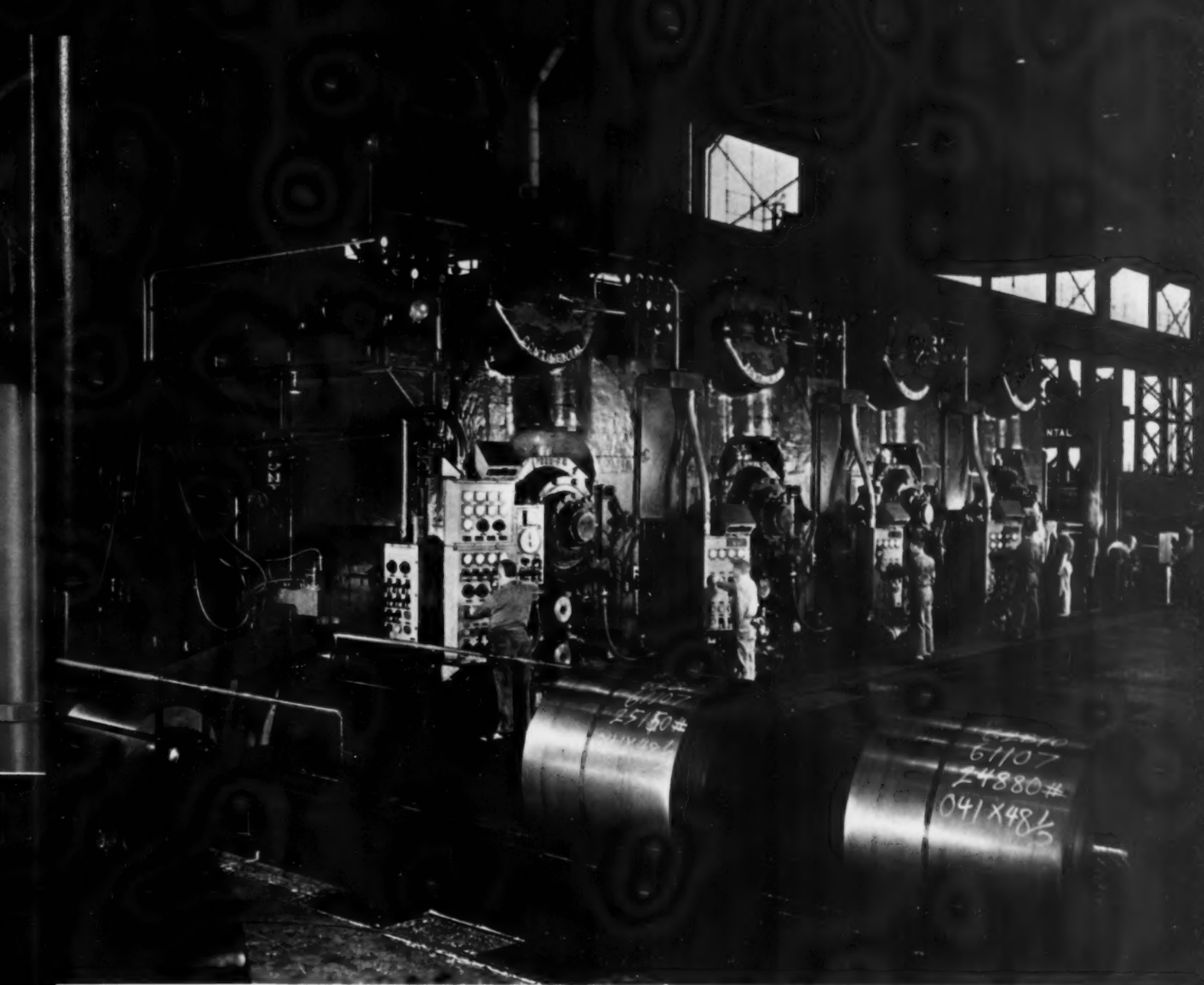
THE GARLOCK PACKING COMPANY, Palmyra, New York

For Prompt Service, contact one of our 30 sales offices and warehouses throughout the U.S. and Canada.

**Registered Trademark*

GARLOCK

Packings, Gaskets, Oil Seals, Mechanical Seals, Rubber Expansion Joints



60-inch, 4-stand tandem cold mill

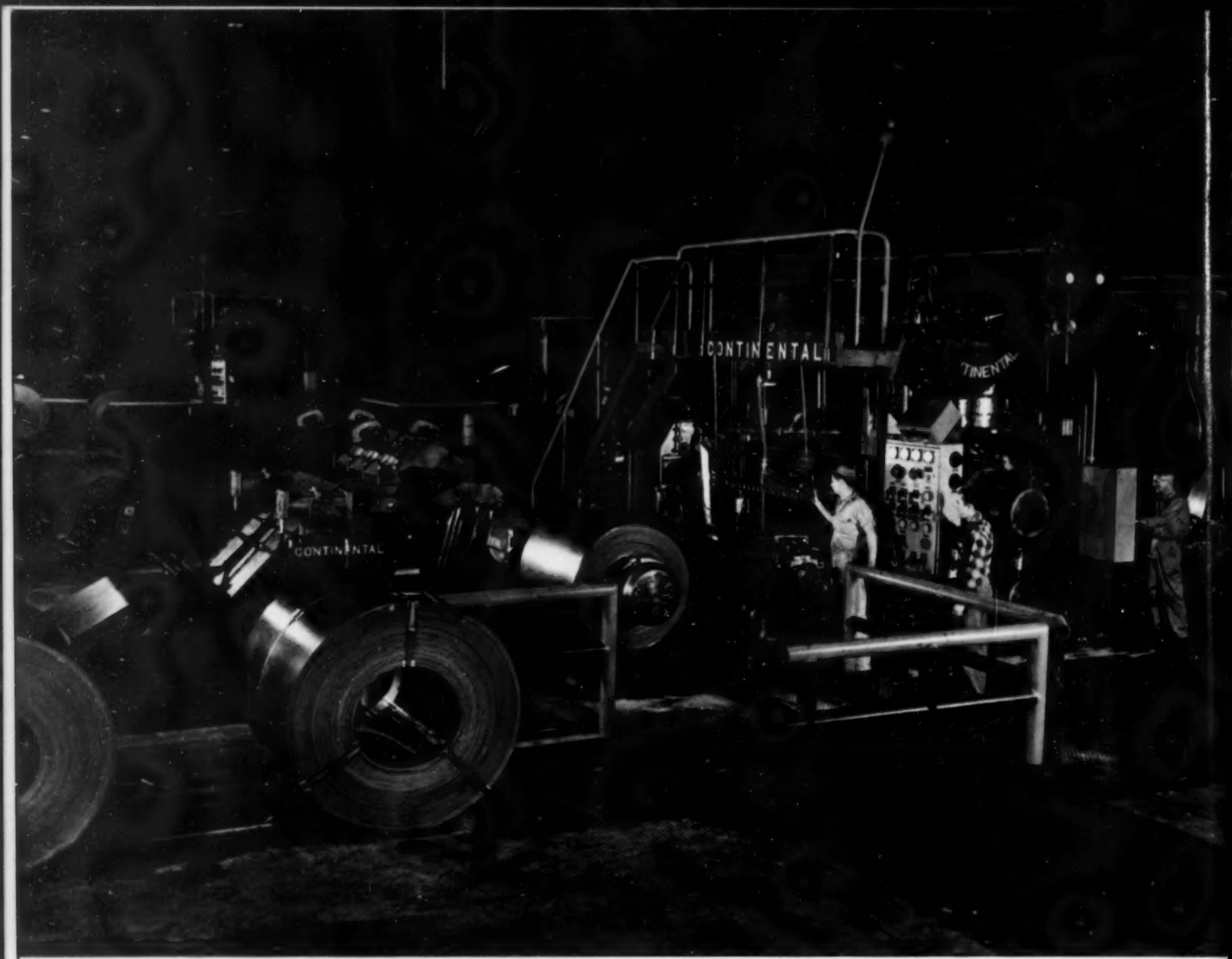
BLAW-KNOX COLD STRIP MILLS

Blaw-Knox designs and builds all types of cold reduction and temper mills for ferrous and non-ferrous work. Other Blaw-Knox equipment for the metals industry includes complete rolling mill installations including all auxiliary equipment for ferrous and non-ferrous metals, iron, alloy iron and steel rolls, Medart cold finishing equipment, carbon and alloy steel castings, fabricated steel plate or cast-weld design weldments, steel plant equipment, and heat and corrosion resisting alloy castings.

BLAW-KNOX

BLAW-KNOX COMPANY

Foundry and Mill Machinery Division
Blaw-Knox Building • 300 Sixth Avenue
Pittsburgh 22, Pennsylvania



60-inch two-high temper mills. They are fed from the annealing building by a downender to floor level entry conveyor. Delivery conveyor is also at floor level.

BLAW-KNOX TEMPER MILLS

Blaw-Knox designs and builds a full range of Temper Mills for integration into your strip and sheet processing operation. Other Blaw-Knox equipment for the metals industry includes complete rolling mill installations including all auxiliary equipment for ferrous and non-ferrous metals, iron, alloy iron, and steel rolls, Medart cold finishing equipment, carbon and alloy steel castings, fabricated steel plate or cast-weld design weldments, steel plant equipment, and heat and corrosion resisting alloy castings.

BLAW-KNOX

BLAW-KNOX COMPANY

Foundry and Mill Machinery Division

Blaw-Knox Building · 300 Sixth Avenue

Pittsburgh 22, Pennsylvania

Knocking down an ingot on schedule places heavy demands on your primary reversing mill. Drives and auxiliary equipment take rough abuse. To give you an edge in meeting demands, Westinghouse drives are engineered from long experience. New advances in Westinghouse automatic controls and coordinated auxiliary equipment keep your mill on schedule.

MP-3051

Experienced engineering and development

KEY TO HIGHER TONNAGE

...with Westinghouse-equipped reversing mills

YOU CAN BE SURE...IF IT'S Westinghouse

Dependability is tailor made

Experience tailors each drive

Today, reversing mill drive equipment takes heavier abuse than ever before. Growing operating and tonnage requirements can't be met by yesterday's set of standards. That's why experienced engineering at Westinghouse tailors each drive to the specific mill. In this way, you can be sure of top performance, maximum accessibility to all parts of the drive, and rugged construction quality for reliability today and long into the future.

The Westinghouse reversing mill drive, at right, is a good example. Main drive is a 12,000 hp., 40/80 rpm double-armature twin motor. Edger drive (top) is a 4,000 hp., 60/150 rpm double-armature motor. Time-saving accessibility is provided by: 1) large walk-in endbells, 2) extra space for brush accessibility, both radially and axially, and 3) absence of baffle restrictions between the commutator area or the stator or rotor windings.

Heavy-duty thrust bearings are located at the mill end of the main drive pedestal bearings to permit easy, routine inspections. Removable end-case permits complete inspection and maintenance without disturbing either journal bearing or bearing cap.

Rugged construction of the Westinghouse reversing mill drive incorporates heavy-duty bedplates supported on concrete foundations. Pedestal cap bolts and base bolts extend deep into foundation concrete. Mill-end bearings are supported by massive pedestals using foundation keys. Each armature coil is rigidly and individually braced, front and rear. Armature coil cross connections are securly encased in a steel box at the rear of the rotor and flexibly connected to armature coils.

Oscillotrol (R) thrust oil-damper system effectively damps out rotor oscillations caused by pulses from mill-spindle coupling action on two-drive motors.

MP-3051

YOU CAN BE SURE...IF IT'S Westinghouse

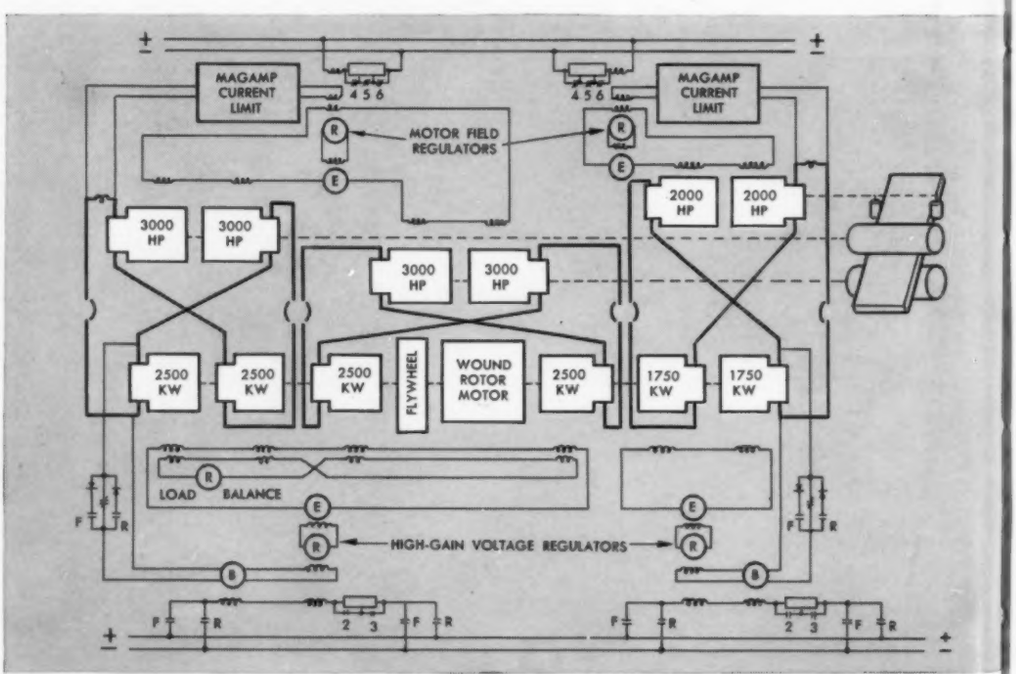
SYSTEM FEATURES

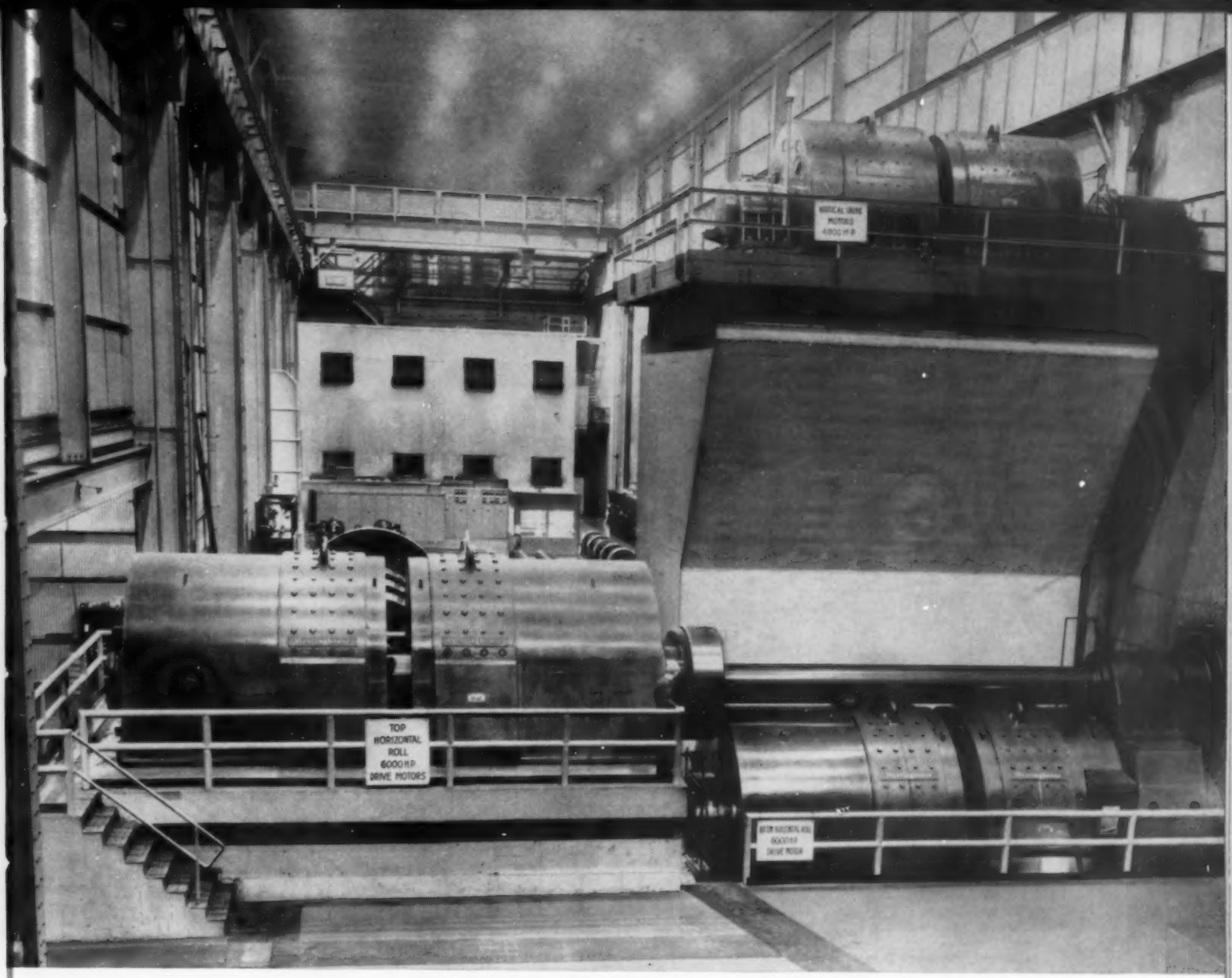
Sandwich series loops are used for each of the pairs of double-armature twin-drive motors and for the double-armature edger motor to minimize the number of circuit breakers and load balance equipment. A load balance regulator excites auxiliary fields on the 2500 kw generators to balance the twin-drive motor loads.

High-gain voltage regulators excite generators to give fast changes in response to the operator's controls.

Motor field regulators excite motors to give changes in speed by motor-field control.

MAGAMP (R) (magnetic amplifier) current-limit regulator builds up motor field strength to increase the torque per ampere for loads approaching 200%.





Typical reversing mill drive using 12,000 hp, 40/80 rpm double-armature twin motor. Edger drive (top) is 4,000 hp, 60/150 rpm double-armature motor.

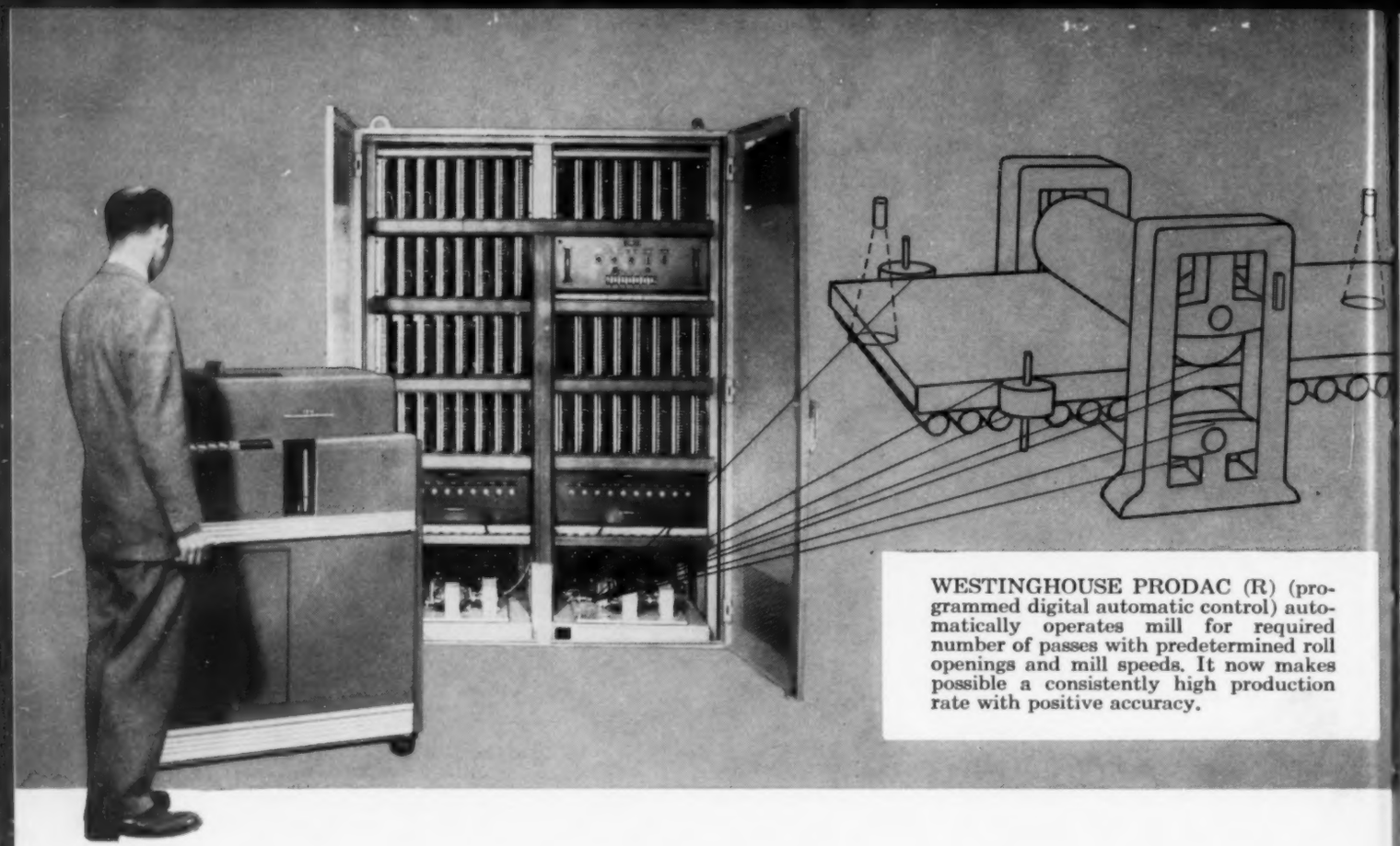
WESTINGHOUSE EQUIPMENT SERVES THESE USERS

YEAR	CUSTOMER	LOCATION	MILL	HP	RPM
1951	U. S. Steel Corporation	Fairless Hills, Pa.	40″ Blooming Mill	8000*	65/130
1951	☆Sheffield Steel Division	Kansas City, Mo.	32″ Blooming Mill	4000	60/150
1951	Laclede Steel Company	Alton, Illinois	35″ Blooming Mill	5000	60/150
1951	Dow Chemical Company	Madison, Illinois	84″ Reversing Mill	6000	55/156
1951	U. S. Steel Corporation	Morrisville, Pa.	Universal Slabbing Mill	12000*†	40/80
1951	°Great Lakes Steel Corporation	Detroit, Michigan	Universal Slabbing Mill	12000*†	40/80
1953	Reynolds Metals Company	McCook, Illinois	144″ Taper Mill	3000	125/250
1954	Inland Steel Company	Indiana Harbor, Ill.	Wide Flange Beam Mill	7000†	80/160
1955	Aluminum Company of Amer.	Davenport, Iowa	160″ Slabbing Mill	7000*	30/60
1955	Empressa Nacional Siderurgica	Spain	132″ Plate Mill	7000*	40/80
1955	Jones & Laughlin Steel Corp.	Cleveland, Ohio	Slabbing Mill	10000*	40/100
1955	Kaiser Al. & Chem. Corp.	Ravenswood, W. Va.	168″ Slabbing Mill	10000*†	30/60
1955	Kaiser Al. & Chem. Corp.	Ravenswood, W. Va.	110″ Slabbing Mill	6000	30/60
1955	Republic Steel Corp.	Cleveland, Ohio	Universal Slabbing Mill	12000*	40/80
1955	Jones & Laughlin Steel Corp.	Aliquippa, Pa.	Reversing Rougher	6000*	40/100
1955	Jones & Laughlin Steel Corp.	Cleveland, Ohio	Reversing Rougher	8000*	40/80
1955	Crucible Steel Co. of Amer.	Midland, Pa.	Roughing Mill	3500	50/150
1955	Armco Steel Corporation	Butler, Pa.	Reversing Rougher	7000	40/100
1956	U. S. Steel Corporation	South Chicago, Illinois	Universal Slabbing Mill	12000*†	40/80
1956	U. S. Steel Corporation	Gary, Indiana	Universal Slabbing Mill	12000*†	40/80
1956	Altos Hornos	Mexico	Blooming Mill	6000*	40/80
1956	Large Eastern Steel Company		Blooming Mill	3000	60/150
1956	Reynolds Metals Company	Listerhill, Alabama	170″ Slabbing Mill	7000*	30/60
1956	Tata Iron & Steel	India	Reversing Rougher	3500*	60/150
1956	Kaiser Steel Company	Fontana, California	90″ Slabbing Mill	10000*	40/100
1956	Olin Mathieson Chem. Corp.	Omal, Ohio	96″ Slabbing Mill	5000	35/70
1956	Empire Steel Corporation	Mansfield, Ohio	Reversing Rougher	5800	50/120

☆Armco Steel Corp. °Division of National Steel Corp. *Twin Drive †Double Armature

MP-3051

Auxiliary equipment takes over more responsibility



WESTINGHOUSE PRODAC (R) (programmed digital automatic control) automatically operates mill for required number of passes with predetermined roll openings and mill speeds. It now makes possible a consistently high production rate with positive accuracy.

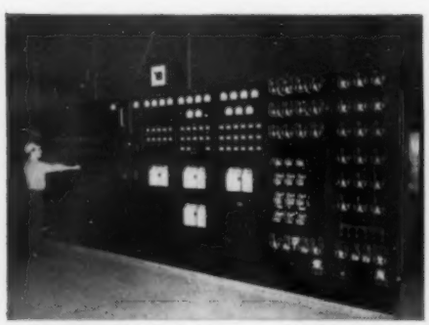
Reversing mills are more precise, automatic with Westinghouse auxiliaries

Continued research and development by Westinghouse helps to make your operations more precise and automatic. A recent example is PRODAC control. It makes possible the first completely automatic mill with card-programmed rolling information.

Unmatched Westinghouse engineering for high-tonnage reversing mill operation is at your service . . . from planning to design, installation and start-up. A skilled Westinghouse team will accept unit responsibility and work with you and your consulting engineers.

Contact your Westinghouse sales office for further details . . . Westinghouse Electric Corporation, 3 Gateway Center, P.O. Box 868, Pittsburgh 30, Pa.

MP-3051



WESTINGHOUSE main-drive control panels provide centralized start-up switches for fans and motor-generator sets, and metering for power and regulating circuits.

WESTINGHOUSE variable voltage control for all auxiliaries minimizes handling time. Transfer switches and emergency bus arrangement afford relief in case of generator failure.

MCT600 INDIVIDUAL TABLE ROLL MOTOR, silicone insulated; drives mill tables directly; in ratings at 230 volts; frame sizes from 604 to 618; 3.75 hp to 50 hp, 157 rpm to 85 rpm.

YOU CAN BE SURE... IF IT'S Westinghouse

Two More Big Ones Ready to Go

Here are two Bethlehem forged-steel rolls that were photographed in the shop as they were being readied for shipment. The unit shown in the background is a real heavyweight, just about as massive as they come. The one being calipered isn't exactly a midget itself.

Because of their overall dimensions, big rolls like these are the "show pieces" of the shops. But of course, they by no means represent the entire Bethlehem line. No matter what size—or what type—you require, Bethlehem will make it for you. Some of the rolls we produce weigh 20 tons or more. Others are so small that they can be lifted by hand.

All Bethlehem rolls, regardless of size, are made with exacting care. When you entrust us with your order, you can be sure that specifications on hardness, finish, and other details will be met in full. And the job will be finished on time.

We suggest you call us the next time you're in the market. Remember, forged-steel rolls have been a Bethlehem specialty for many years.

TYPICAL USES FOR BETHLEHEM FORGED-STEEL ROLLS

Cold-rolling ferrous sheets and strip

Running-down and finishing operations on copper and brass sheets

Hot- and cold-rolling aluminum sheets

Cold-rolling aluminum foil

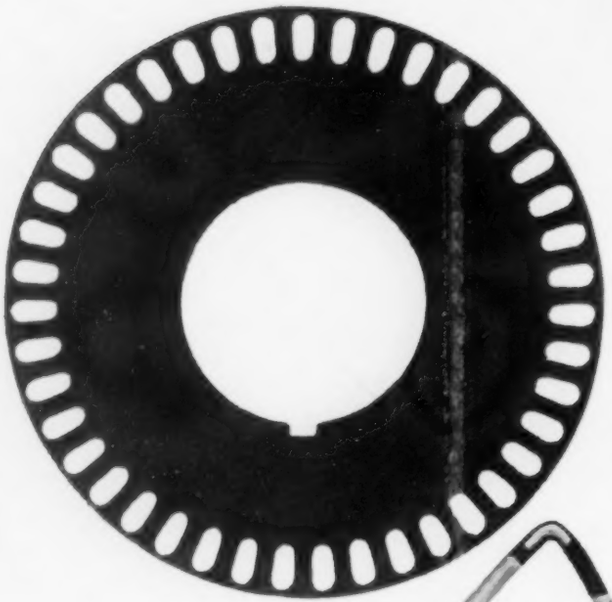
BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

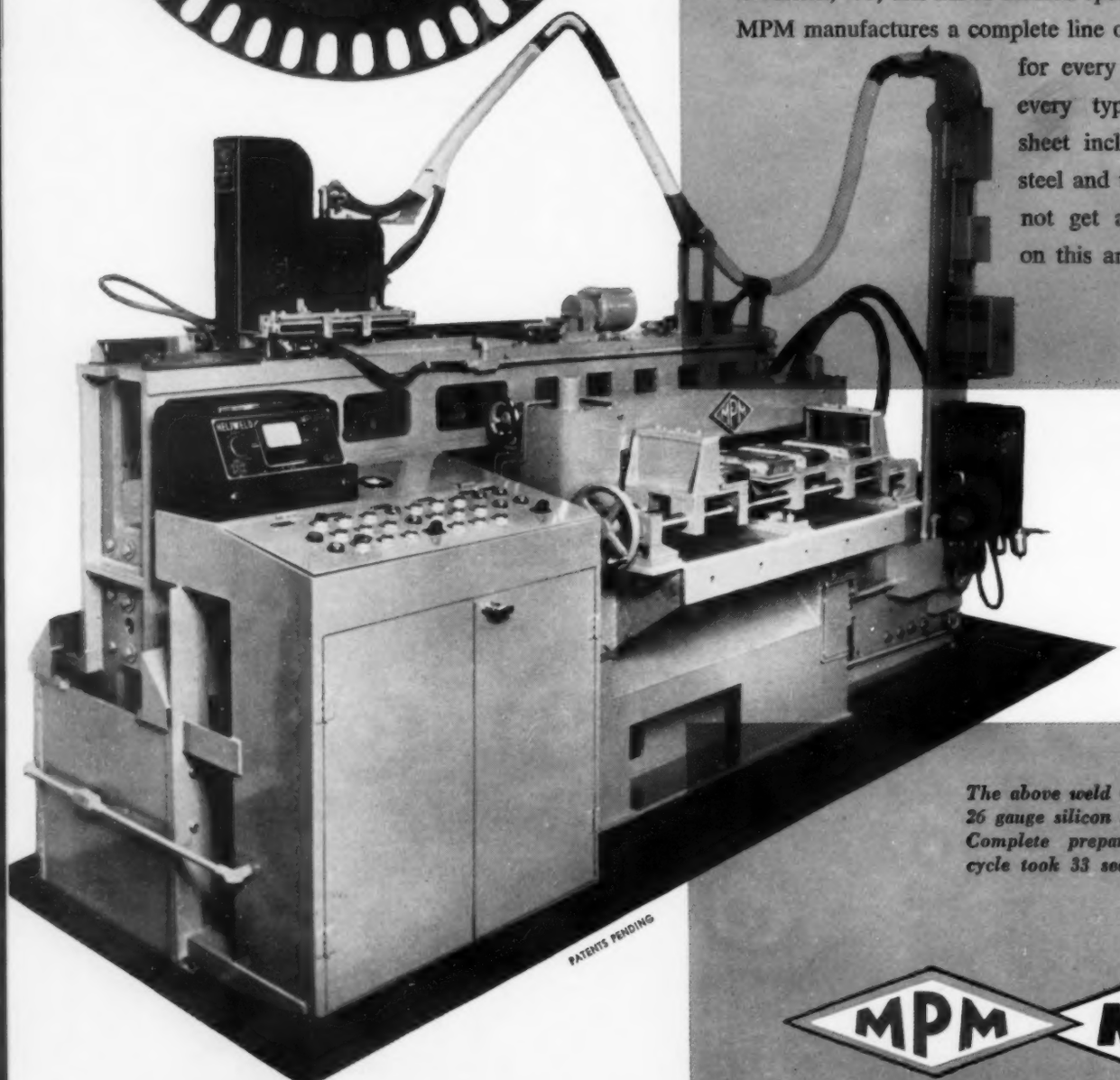
BETHLEHEM STEEL

BETHLEHEM STEEL

Silicon steel coil buildup made faster, more accurate by amazing MPM shearwelder



• The unretouched photo of the rotor lamination is a typical production butt-weld made on 26 gauge silicon steel by MPM's outstanding new Shearwelder. Perfect welds like this are a result of the exclusive positive guiding and clamping arrangement and welding technique developed by MPM engineers. Both shearing and welding are performed at the same station eliminating the chance for error that occurs when the work is moved from station to station, too, this MPM method speeds the operation. MPM manufactures a complete line of Shearwelders for every need, and for every type of strip and sheet including stainless steel and tin plate. Why not get all the facts on this amazing machine?

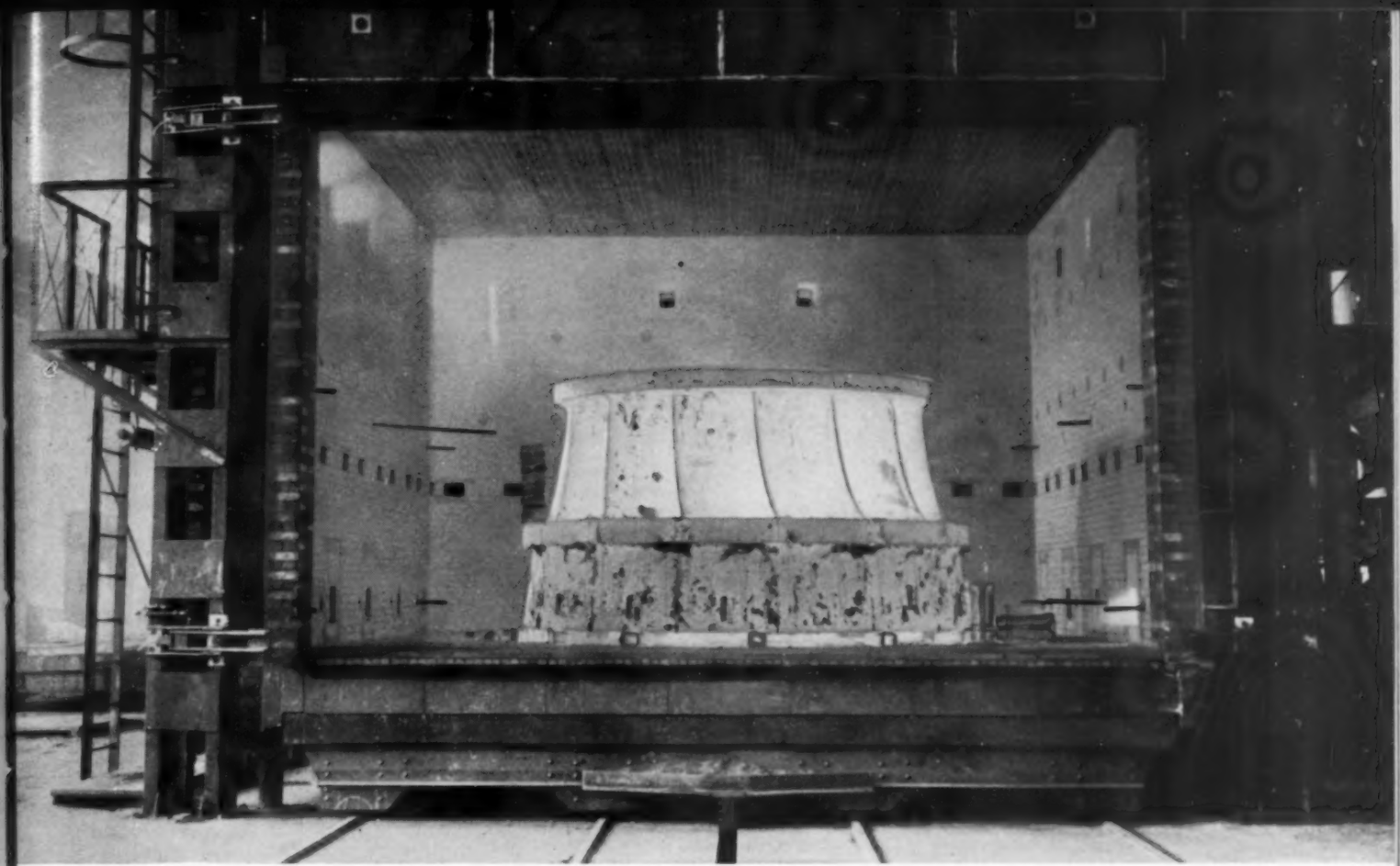


The above weld was made in joining 26 gauge silicon steel sheet 33" wide. Complete preparation and welding cycle took 33 seconds.

MPM McK

METAL PROCESSING MACHINE COMPANY • YOUNGSTOWN, OHIO

Subsidiary of THE McKAY MACHINE CO.



For best performance and maximum economy

7 different specialized refractories used in annealing furnace lining

Engineering a furnace lining with *specialized* refractories can save dollars on construction, fuel and maintenance as well as extend productive working time. To achieve these results, seven different B&W refractories were used in the lining of this 25′ x 23′ x 14′ annealing furnace.

Fuel savings and close temperature control were made possible by using three types of *lightweight* B&W Insulating Firebrick. Walls are composed of *B&W K-23 IFB* backed up with *B&W K-16*. Because of the proximity of the burners, the roof was constructed of *B&W K-26 IFB*, a higher temperature brick to guard against the effect of possible localized overheating.

The weight saving construction means about 100 lb less refractory material to heat up per sq ft than with ordinary firebrick, or about 28 tons less in the roof of the furnace. Furthermore, supporting steel is less massive, far less costly. Commercial size steel can be used for roof suspension instead of special steels.

To eliminate the need for expensive special shapes, the burner tunnels are formed of *B&W's 3000 F refractory castable, Kaocast*. Lintels over the burners and jambs are constructed of rugged *B&W Junior Firebrick*.

To take advantage of fast, easily installed castable construction, *B&W Kaocrete-D* was used in the nose arch (separately pictured). This sturdy castable with a 2500 F use limit was selected to provide strong resistance to abrasion caused by door operation. In addition, the need for costly fired shapes and their supporting castings was eliminated, as was a great deal of expensive engineering detailing.

Nose arch, cast of B&W Kaocrete D, immediately after removing forms.

The car top is insulated with *B&W Kaolite-20*, a 2000 F insulating refractory concrete.

For further information, write for B&W bulletin R-2-H on insulating firebrick and B&W bulletin R-35 on castables.

BABCOCK & WILCOX

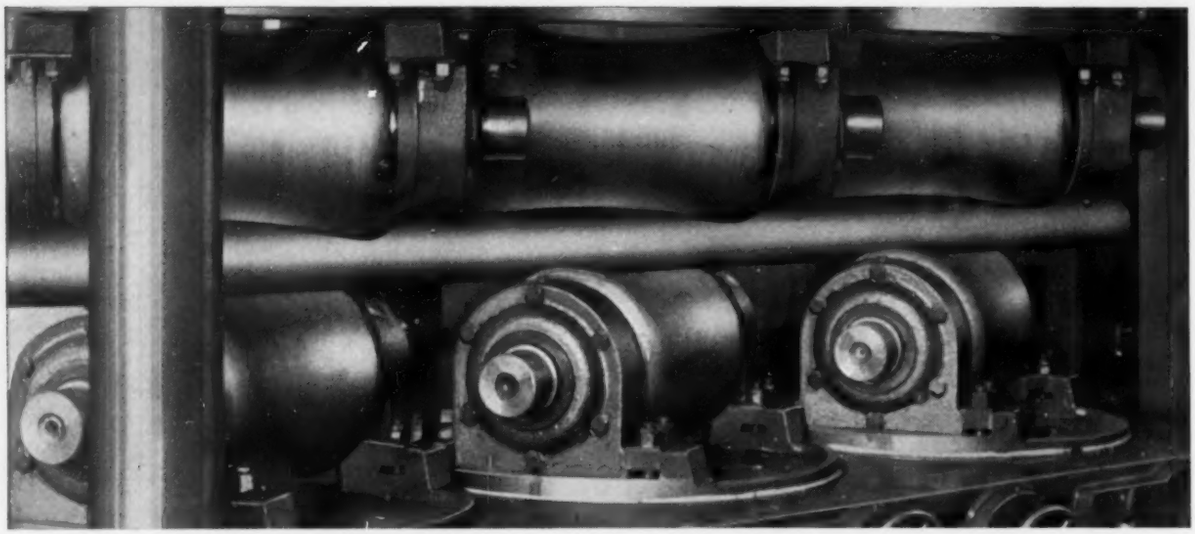
THE BABCOCK & WILCOX CO.
REFRACTORIES DIVISION
GENERAL OFFICES: 161 EAST 42nd ST., NEW YORK 17, N.Y.
WORKS: AUGUSTA, GA.

R-574

TIPS FROM A ROLL MAKER'S NOTEBOOK

MACKINTOSH-HEMPHILL DIVISION, E. W. BLISS COMPANY, Pittsburgh 3, Pennsylvania

Cast mill rolls • Johnston cinder pots • rotary tube straighteners • end-thrust bearings • heavy-duty lathes • steel and special alloy castings



Line contact of rolls and tubing is shown clearly in this photograph of a tube length passing through the rolls of a Mack-Hemp rotary tube straightener.

Odd twists on roll wear in rotary tube straighteners

The production straightening of pipe and tube by passing it between concave cross rolls is quite unique in the demands it places on the rolls. For example, slippage – the bane of most rolling operations – is a necessity in a rotary tube straightener. Without slippage, the straightened tube will show spiral markings.

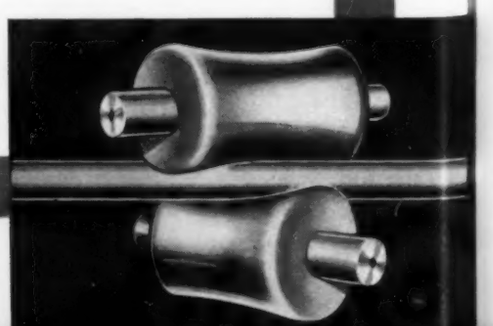
An unattainable goal—Another unusual characteristic of this service is that when properly set, the rolls should wear evenly over their entire work surfaces. This is because the tubing makes a line contact with the roll surface. Thus, under ideal conditions, straightener rolls would operate continuously to worn-out diameter without any redressing at all.

Unfortunately, it is impossible to achieve this ideal. Any given straightener is usually designed to be used with a range of tube diameters. Hence, roll curvature must be for average diameter, a compromise.

First rolls used were "overspecified"—Mack-Hemp engineers have made a very thorough study of straightener rolls—Mack-Hemp itself builds a type of rotary tube straightener. At first, we believed that hard forged steel roll rings on forged steel shafts would be necessary for neck strength and wear resistance, but soon learned that cast steel rings gave longer life. As time went on, we used integral cast steel rolls for economy. Then cast iron rings on forged steel shafts proved best for wear and finally we found solid cast iron rolls to be sufficiently strong and most economical.

Solid grain iron rolls best—Today, we use cast-to-shape low-alloy grain iron rolls in the larger straighteners we build, and recommend their use in most other rotary tube straighteners. (In small straighteners, hardened steel rolls are still practical because of the relatively higher cost of small chilled castings). Mack-Hemp "Technigrain" rolls have ample strength for this service. Casting to shape provides a uniform depth of hardness over the entire surface, while the graphite in the iron has the "lubricant" quality needed for slippage without excessive wear.

The history of tube straightener rolls shows how Mack-Hemp's broad experience in all phases of roll use can help you choose exactly the right roll. Feel free to call on us at any time... there's no obligation.



MACKINTOSH-HEMPHILL

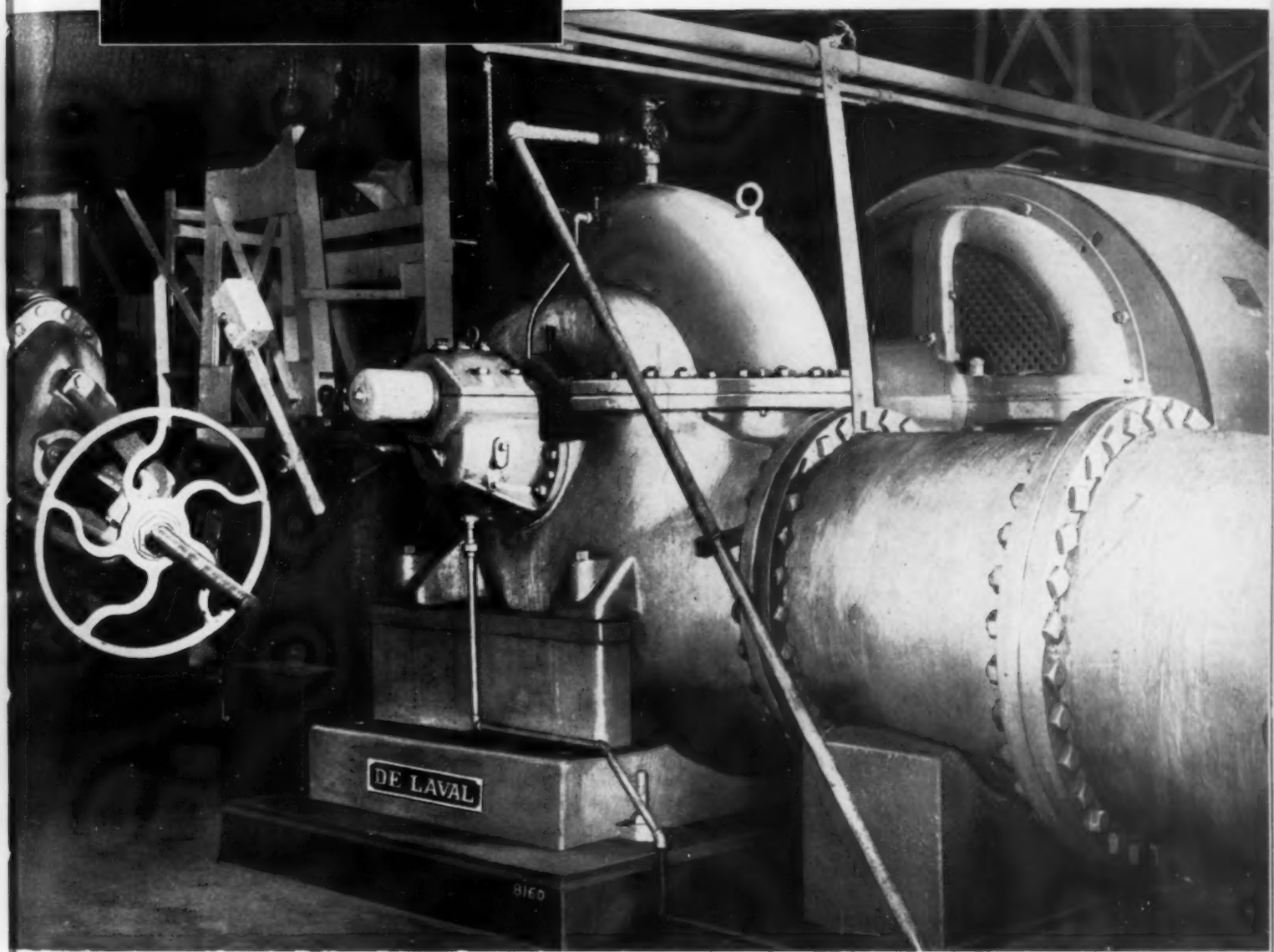
You get more tonnage from the rolls with the Striped Red Wabblers

Division of E. W. BLISS COMPANY

Presses, Rolling Mills, Special Machinery

DE LAVAL
CENTRIFUGAL PUMPS

in service since 1911 at Inland Steel Co.



De Laval Centrifugal Pumps have a record of dependability at the Inland Steel Co., which goes back forty-five years. In that time, De Laval has supplied this major producer with pumps for practically every steel mill service—*more than 75 units in all.* The photograph shows one of the largest De Laval pumps on the line at the East Chicago, Indiana plant of Inland Steel. The unit delivers 20,000 gpm at 120 ft head.

De Laval Centrifugal Pumps are available for a wide range of applications in all types of metal-working plants. Types L, M and P single stage double suction pumps can handle capaeities from 1,000 to 20,000 gpm and heads to 350 feet. Larger De Laval units of any capacity to meet any requirement for steel mill service are available.

Send for Bulletin 1004 giving performance and application data.

DE LAVAL *Centrifugal Pumps*

DE LAVAL STEAM TURBINE COMPANY
870 Nottingham Way, Trenton 2, New Jersey

DL348

MAKE SURE YOUR NEXT BULK MATERIALS HANDLING BRIDGE HAS THESE IMPORTANT DRAVO FEATURES:

- Double Web Truss System with Beam Sections
- Positive Wind Protection with Dravo Rail Clamps
- Fully Equalized Loading on Truck Wheels
- Use of Unit Construction for Mechanical Elements
- Trolley Accident Prevention with Dravo Hydraulic Buffers

LIBERAL USE OF WELDED COMPONENTS

Shop Assembly of Welded Pier Leg—Accurate alignment is always assured as welds will not loosen. All connections are sealed, maintenance is simplified, and hidden corrosion is avoided.

DRAVO Ore Bridges...

welded construction used to assure strength and rigidity

The use of welded construction at key points is one of the many features which add to the life and usefulness of Dravo bulk materials handling equipment. Many other operating economies result from the fact that each structure is individually designed to handle its specific job economically, dependably and safely. Such performance is achieved by bringing together the customer's operating knowledge and the experience of Dravo's research, design and construction men.

This method has resulted in high efficiency bridges and other bulk materials handling equipment that produce because they are tailored to fit the job. Dravo engineering features, built into every structure, provide for low maintenance and operating costs. For complete information write to Dravo Corporation, Pittsburgh 25, Pa.

DRAVO
CORPORATION

Blast furnace blowers • boiler and power plants • bridge sub-structures • cab conditioners • docks and unloaders • dredging • fabricated piping foundations • gantry and floating cranes • gas and oil pumping stations • locks and dams • ore and coal bridges • process equipment • pumphouses and intakes • river sand and gravel • sintering plants • slopes, shafts, tunnels • space heaters • steel grating • towboats, barges, river transportation

Self-aligning TO KEEP ITS CAPACITY IN ROUGH, RUGGED SERVICE

THIS IS SELF-ALIGNMENT. Spherical inner ring is free to align itself in any direction. Thus . . .
FULL LOAD CAPACITY is always assured, regardless of shaft deflection or misalignment.
Series 22200 and 22300 —22500-A and 22600-A roller bearings

Spherical LINK-BELT roller bearing compensates for shaft deflection, weaving of supports

MANY leading makers of tough duty equipment now design without bulky supports to prevent deflections. They're using this spherical Link-Belt roller bearing that *compensates for misalignment* . . . always keeps its full capacity for handling radial and thrust shock loads without "pinching."

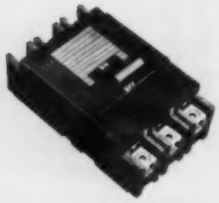
In addition, it's factory-adjusted, easy to mount and available everywhere with internationally standardized boundary dimensions.

Link-Belt also makes industry's most complete line of ball and roller bearing blocks. They're all in Book 2550—yours for the asking at any Link-Belt office or Authorized Stock-Carrying Distributor. 14,443-A

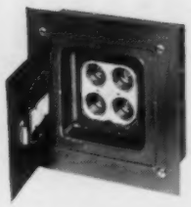
LINK-BELT

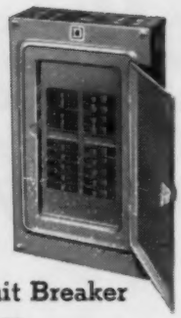
self-aligning ball and roller bearings

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville (Sydney), N.S.W.; South Africa, Springs. Representatives Throughout the World.



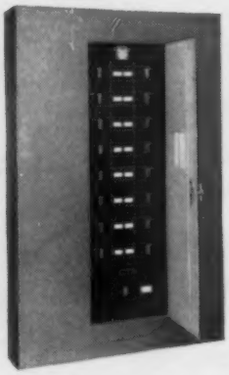
• Safety Switches and
Industrial Circuit Breakers



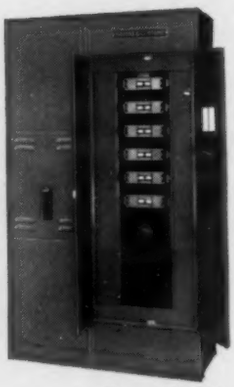


• Fusible and Circuit Breaker
Load Centers

• Voltage Testers

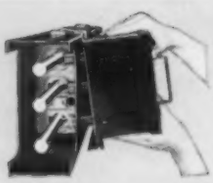


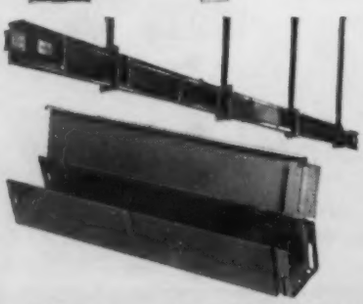
• Fusible and Circuit Breaker
Lighting and Power Panelboards



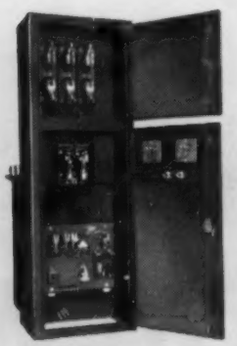
• Power Distribution Switchboards
and Switchgear

Wherever Electricity

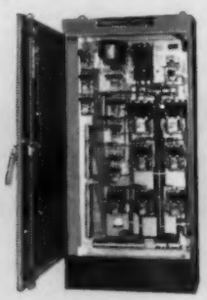




• Busways and Wireways



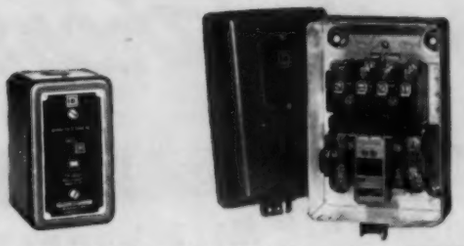
EC&M
High Voltage and
Synchronous Starters



• Special Purpose
Control

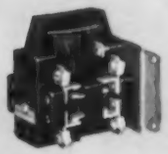
• Control Centers

SQUARE D COMPANY

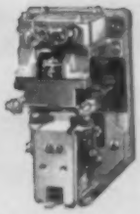


• A.C. Manual and Magnetic Starters

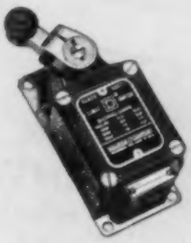
• Drum Switches



• Control Relays

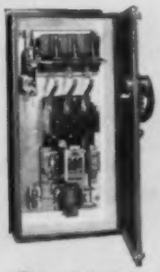


• Timing Relays



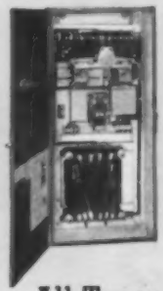
• Limit Switches

• Pushbuttons

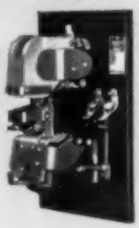


• Combination Starters

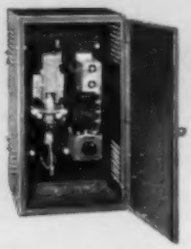
• Manual Compensators



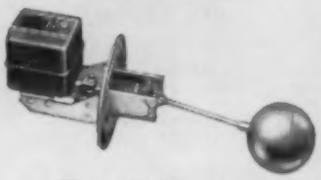
• All Types of Reduced Voltage Starters

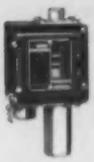


• D.C. Starters



• Electronic and Electro-Magnetic Welder Control

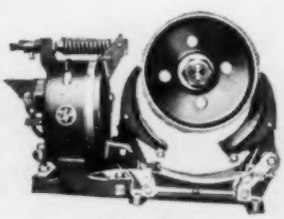




• Float & Pressure Controls for Pumps & Compressors

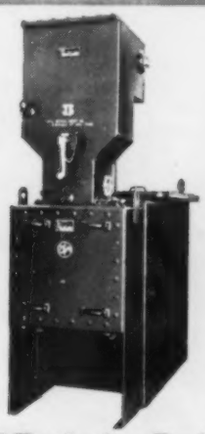
is Distributed and Controlled

EC&M
Lifting Magnets

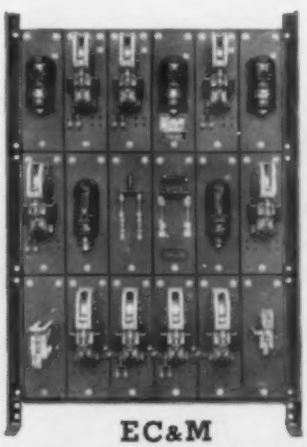


EC&M
Magnetic Brakes

FIELD ENGINEERING SERVICE
available through Square D branch offices
in all principal United States cities
... and in Canada, Mexico and England



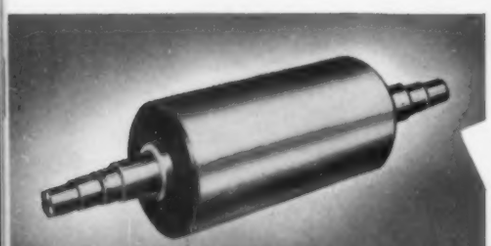
EC&M Explosion-Resisting
Control for
Petroleum Industry



EC&M
Crane and Mill Control

DESIGN LEADERSHIP FOR MORE THAN 50 YEARS

"Y.F.&M." builds the best of them!

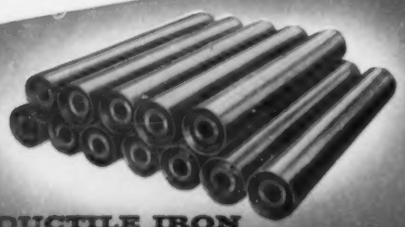


PARALLOY

HOT STRIP COILER ROLLS • COILER PINCH ROLLS
PICKLING LINE PINCH ROLLS • UPCOILER ROLLS
CLEANING LINE PINCH ROLLS • SINKER ROLLS
CARRIER ROLLS • TEMPER MILL TENSION REELS

INSIDE KNOWLEDGE OF STRIP MILL PROBLEMS

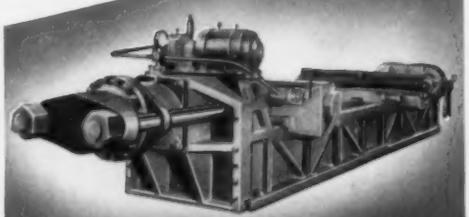
PLUS
more than
70 YEARS EXPERIENCE
building what
you need



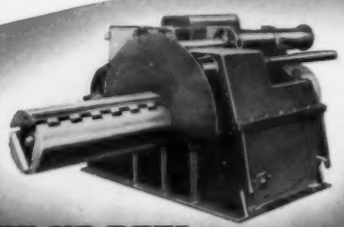
DUCTILE IRON

RUNOUT TABLE ROLLS
HOLDING TABLE ROLLS
LOOPER TABLE ROLLS
LOOPER TABLES
APRON PLATES

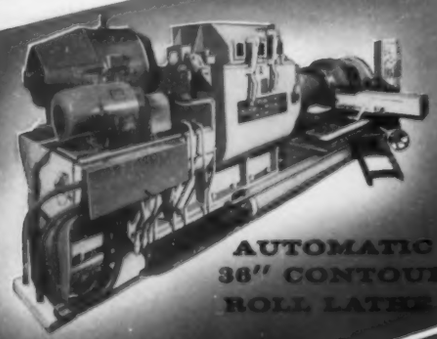
Ductile Iron Castings up to 50,000 lbs.



90" X 240" X 1/4"
STRETCHER LEVELER



TAKE UP REEL
Complete Slitting Lines and Equipment



AUTOMATIC
36" CONTOUR
ROLL LATHE

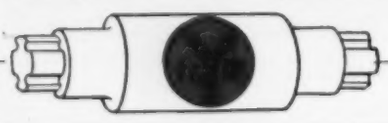
Other Capacities
24" — 48" — 60"

YOUNGSTOWN

HOT and COLD STRIP MILL MAINTENANCE SPECIALISTS

"YOUNGSTOWN" service is based on thorough understanding of strip mill problems and experience in solving them. For example, the problems of scratching, galling, pickup and excess wear are solved by the use of **PARALLOY ROLLS.** Their uniform hardness all through means you can roll more tonnage from new to scrap diameter. **"YF&M" DUCTILE IRON ROLLS** are the proven answers in overcoming heat check, warpage and cracking . . . especially good under the sprays. **"YOUNGSTOWN" MACHINERY** serves major steel mills from coast to coast.

Consult us about your problems.
Let us quote on your requirements.



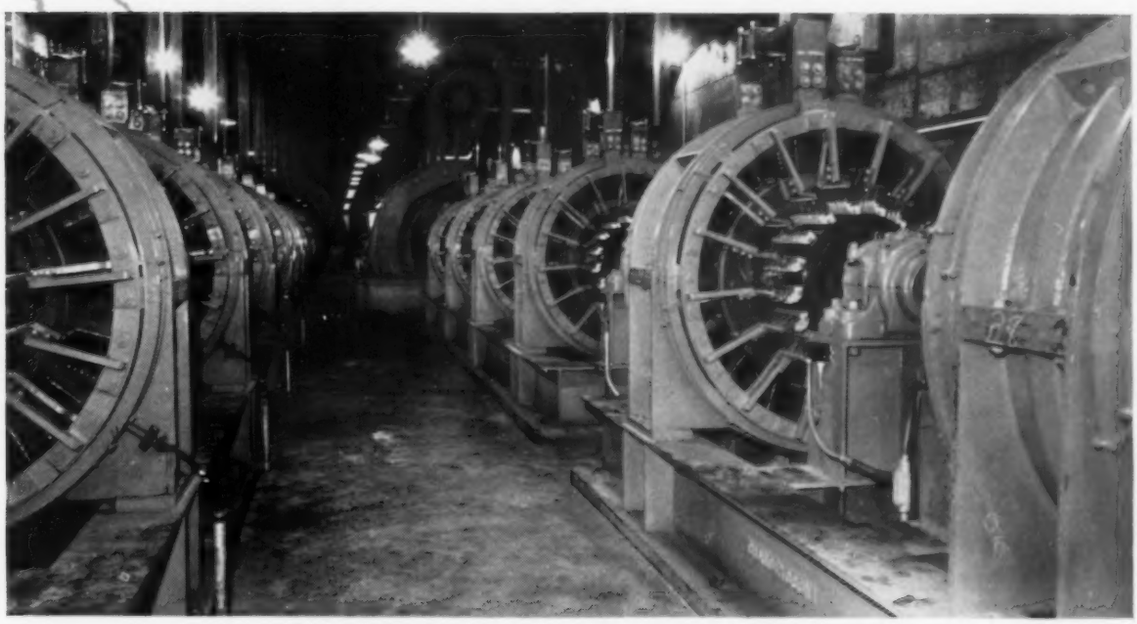
The Youngstown Foundry & Machine Company

SERVING INDUSTRY SINCE 1885

Youngstown 1, Ohio

DEFEAT THE HEAT

proof that motor generators are your best investment in power conversion equipment



Youngstown Sheet and Tube Co. *beats the heat* with four 72,000 ampere, 20 volt Chandeysson M.G. Sets. Each is driven by a 2,500 HP, 300 RPM synchronous motor.

Chandeysson

Generators are built to take the heat, heavy punishment under severest operating conditions

Throughout the iron and steel industry, companies rely on Chandeysson Motor Generators as their most dependable form of low-voltage power . . . because Chandeysson M. G. sets are built to *take it!* Hot summer temperatures and overloads are no problem . . . operate continuously in 40 degrees C. rooms and, if necessary, at 50 degrees C. . . . can carry 115% current and 110% voltage simultaneously, continuously. For short times, these M. G. sets will carry up to 150% load . . . without damage.

These are just a few examples of Chandeysson *performance* engineering. Behind every generator are decades of engineering and manufacturing know-how . . . consistent employment of only the finest, most durable materials . . . and user testimony to highest standards of performance and life-long service. For extra capacity to meet emergencies at the lowest possible cost . . . whatever your needs are in power conversion equipment . . . insist on Chandeysson low-voltage generators.

GET ALL THE FACTS on how you can gain lifetime power dividends with a Chandeysson Motor Generator set. Mail this coupon . . . Now!

CHANDEYSSON ELECTRIC COMPANY
4076 Bingham Avenue, St. Louis 16, Mo.

Please send new booklet D-103

Name..... Title.....

Company.....

Address.....

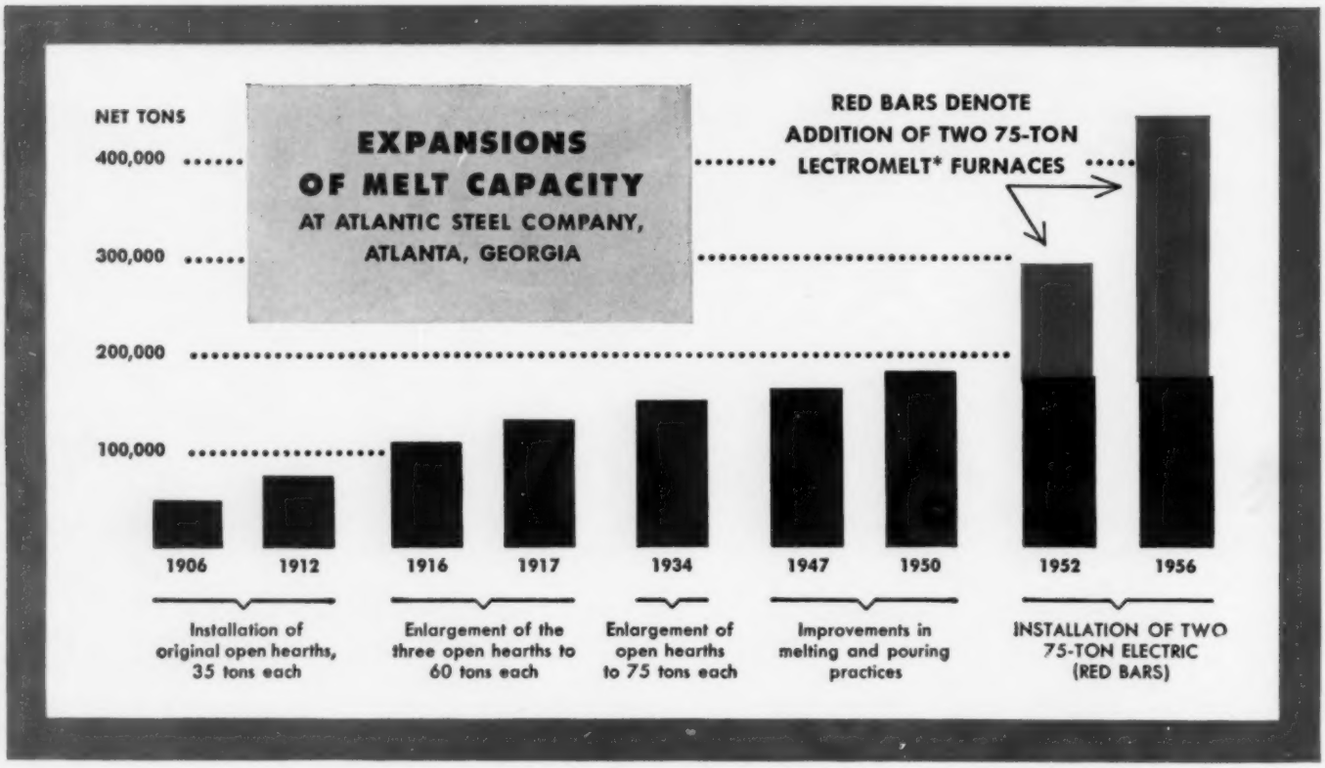
City..... Zone..... State.....

CHANDEYSSON ELECTRIC COMPANY

• 4076 Bingham Avenue • St. Louis 16, Missouri

ATLANTIC STEEL

compares open hearth and electric furnaces



For equivalent open hearth capacity:

Electric furnace first cost is 40% less.

Space allowed for 3 electric furnaces is ⅓rd less.

Electrics get into production faster.

More precise temperature control and no contamination from fuels.

Faster heats, because charging time is cut in half.

Greater flexibility; need run only to suit demands.

Operating costs are consistently lower; ingots average 5% less.

Catalog 9-B describes Lectromelt Furnaces.
Lectromelt Furnace Division, McGraw-Edison Company,
310 32nd Street, Pittsburgh 30, Pennsylvania.

Lectromelt

*Reg. T. M.
U. S. Pat. Off.

STANDARD SIZES UP TO TWO HUNDRED TONS CAPACITY

ITALY: Forni Stein, Genova ... JAPAN: Daido Steel Co., Ltd., Nagoya ... ENGLAND: Electric Furnace Co., Ltd., Weybridge ... GERMANY: Demag-Elektrometallurgie, GmbH, Duisburg ... SPAIN: General Electrica Espanola, Bilbao ... FRANCE: Stein et Roubaix, Paris ... BELGIUM: S. A. Stein & Roubaix, Bressoux-Liege.

Association

50 YEARS

of Iron and Steel

OF

Engineers

AISE

50 YEARS OF AISE
AISE

THROUGH the past 50 years, the iron and steel industry has made amazing history. Capacity has grown five-fold. Product quality has improved and production efficiency increased in giant strides. Through this exciting period the Association of Iron and Steel Engineers has been a partner in the industry's remarkable development.

In 1907, the steel industry of the United States was already 50 years old but nevertheless only foreshadowed the giant it was to become. Production that year was 25,781,361 gross tons of iron and 23,362,594 gross tons of steel ingots. Modern units of that time were 16-ft hearth blast furnaces producing as much as 350 tons of iron per day, and 40- or 50-ton open hearths. Coke came almost entirely from bee-hive ovens. The open hearth process had just caught up to the bessemer process as a steel producer. The first direct-arc furnace in the United States for steelmaking had just been installed. Steel capacity totaled about 34,000,000 tons a year.

Steam was the principal motive power. Electricity was a new phenomenon in the industry. It had been applied to cranes, lighting and a few auxiliaries. In the United States, the first application of direct-current motors to mill tables was made in 1893 at Homestead Steel Works, although some mill tables were still driven by steam engines as late as 1938. The first application of main mill drive motors—two 1500 hp, 220 volt d-c units—was on a rail mill at Edgar Thomson Steel Works in 1905 and the first reversing drive (two 1000-hp, 575-volt d-c motors on one shaft) was put on a 30-in. universal plate mill at South Works of Illinois Steel Co. in 1907.

Electrical equipment then available was largely of general purpose design, not well adapted to the rigorous service of the steel industry. The "mill motor," which first appeared in 1893, was actually designed for electric traction cars. Also, the application of electricity in the industry posed many problems—problems unique to the industry and formidable to the men in the relatively new field of steel plant electrical work.

THE BEGINNING

Hence, it is not surprising that the men in these jobs felt the need of banding together. It started in April, 1907, at an informal meeting of 28 electrical engineers from the steel industry. They had met to inspect a special exhibit of electrical equipment for use in iron and steel plants. Present at this meeting were:

James F. Chapman, Colorado Fuel & Iron Co., Pueblo, Colo.
Palmer Collins, American Steel & Wire Co., Pittsburgh, Pa.
Harry A. Cox, Carnegie Steel Co., Donora, Pa.
R. B. Davenport, Carnegie Steel Co., New Castle, Pa.
James Farrington, La Belle Iron Works, Steubenville, O.
J. F. Jelley, Phoenix Iron Works, Phoenixville, Pa.
D. J. Jones, Republic Iron & Steel Co., Youngstown, O.
O. R. Jones, Youngstown Sheet & Tube Co., Youngstown, O.
Frank Kittredge, Illinois Steel Co., Joliet, Ill.
A. T. Koehler, National Tube Co., Wheeling, W. Va.
H. M. Latham, American Steel & Wire Co., Worcester, Mass.
H. A. Lewis, Alan Wood Iron & Steel Co., Conshohocken, Pa.
George H. McFeeters, Lorain Steel Co., Johnstown, Pa.
Robert W. McGarvey, Carnegie Steel Co., Sharon, Pa.
Frank W. McKee, Carnegie Steel Co., South Sharon, Pa.
L. R. Palmer, Jones & Laughlin Steel Co., Pittsburgh, Pa.
Alexander Paterson, Seneca Iron & Steel Co., Buffalo, N. Y.
John C. Reed, Pennsylvania Steel Co., Steelton, Pa.
George W. Richardson, American Bridge Co., Philadelphia, Pa.
R. R. Shepherd, Inland Steel Co., Indiana Harbor, Ind.
W. E. Snyder, American Steel & Wire Co., Pittsburgh, Pa.
F. W. Stevens, American Bridge Co., Ambridge, Pa.
G. W. Sturgess, Lackawanna Steel Co., Buffalo, N. Y.
James Watters, Bethlehem Steel Co., Bethlehem, Pa.
G. H. Winslow, National Tube Co., Pittsburgh, Pa.
Fred H. Woodhull, Lukens Iron & Steel Co., Coatesville, Pa.
A. J. Woodworth, Maryland Steel Co., Sparrows Point, Md.
E. W. Yearsley, Midvale Steel Co., Philadelphia, Pa.

One of the group, James Farrington, suggested the formation of a national organization of "men in charge of electrical departments of iron and steel industries, to increase co-operation between the makers and users of electrical apparatus in iron and steel works and to secure improvements in such apparatus." Approval of

the idea is indicated by the minutes of this preliminary meeting, which show that each of the 28 men chipped in one dollar.

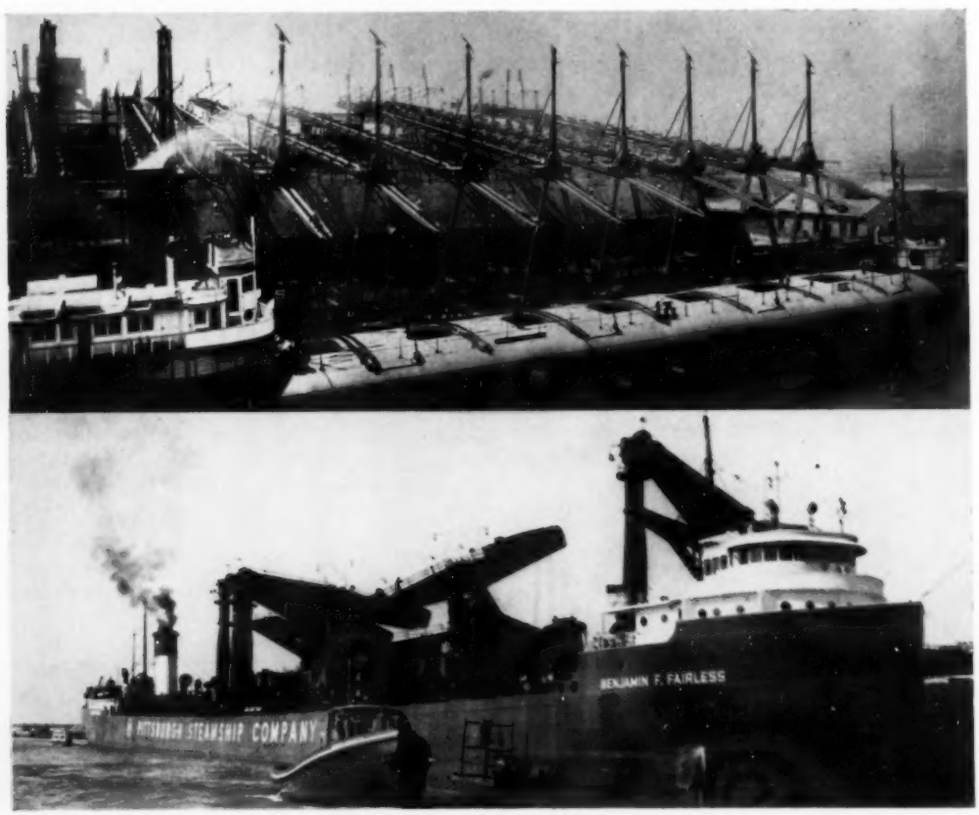
The following October, which saw the start of a serious panic, also brought the first annual meeting to Pittsburgh, with 15 members and 8 guests. The group adopted the name "Association of Iron & Steel Electrical Engineers" and elected James Farrington president, John C. Reed first vice president, G. M. Sturgess second vice president, G. H. Winslow secretary and E. W. Yearsley treasurer. The Fort Pitt Hotel served as headquarters and meetings were held in the auditorium of the Engineers Society of Western Pennsylvania in the Fulton building. Dues were set at $10 a year (which still prevails), although the minutes reflect some sentiment that "a membership fee of $10 would keep out a number of men who would not want to go in that deeply until they see what they are going to get."

The program for this first meeting included 18 papers on such subjects as control and acceleration of electric motors, heavy duty d-c motors, large motors for rolling mills, mill motors, pit cranes, lighting, steam turbines, generators, etc.

The second meeting was held in June, 1908, at the Hotel Walton and the Engineers' Club of Philadelphia, and was attended by 15 members out of the total 33. The program carried 14 papers discussing electric motors for heavy torque and rapid reversal, control of auxiliary motors, storage batteries, centrifugal compressors, etc. The standardization of mill motors was begun and, significantly, a safety committee was formed in 1908.

An interesting side light on the problems encountered by the pioneer members is found in a financial report presented in 1909:

"Dues received 1908–9.....	$754.50
Bills paid, 1908–9.....	$568.49
Balance on hand...	$186.01
Accounts payable.....	$263.00"



Great strides have been made in ore handling, as evidenced by comparison of the whaleback carrier and unloaders of 1900 with the modern carrier and unloading facilities of today.

SAFETY

By 1909, safety was a major item of the meeting held in Buffalo in June and safety continued to be an important feature for several years. It was soon recognized, however, that the safety movement must spread through all industries.

Accordingly, under date of September 1, 1912, the Association's safety committee, under the chairmanship of L. R. Palmer, sent invitations to all industries to attend a Cooperative Safety Congress to be held in Milwaukee, Wis., September 30–October 5, 1912, in connection with the Association's annual convention. This meeting was attended by men from mining, manufacturing and transportation industries and from federal and state governments.

A resolution adopted at this meeting says:

"Whereas, the Association of Iron and Steel Electrical Engineers, regarding as worthy of particular attention the hazards to life involved in electrical operations in steel mills, and appreciating the importance of the general safety movement not only in electrical engineering, but also in the steel industry as a whole, and in all other varied and important industries of our country, and having met with such prompt cooperation in their proposals to establish a national organization devoted to securing increased safety to human life, have reached the conclusion that such an organization can best be brought about by action at this joint meet-

ing of the Association of Iron and Steel Electrical Engineers and the Cooperative Safety Congress, and it is therefore hereby

"Resolved, that the president of the Association of Iron and Steel Electrical Engineers be requested to take the first steps toward the formation of a national organization for the promotion of safety to human life by appointing a Committee on Permanent Organization, which shall contain representatives of the Federal and State agencies already established to supervise conditions of safety in our industries, and shall also contain representatives from the mining, transportation and manufacturing industries of the United States, and be it further

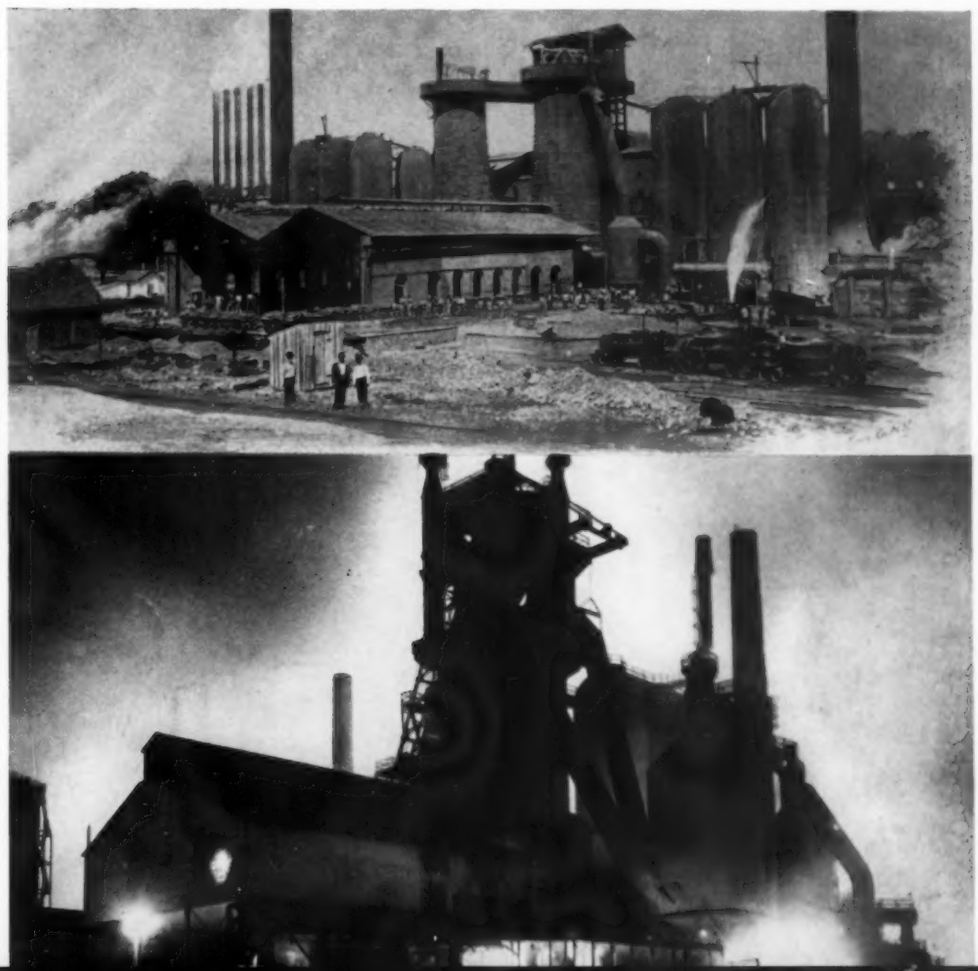
"Resolved, that the Committee so appointed shall be and hereby is authorized by this Congress to organize and to create a permanent body devoted to the promotion of safety to human life in the industries of the United States; this committee to have authority to call future Congresses of Safety, increase its membership if it so desires, and to do such other acts as will promote the object for which it is established."

The committee appointed by the Association president Barton R. Shover consisted of the following:

Dr. Charles P. Neill, U. S. Commissioner of Labor
Dr. Joseph A. Holmes, Director, Bureau of Mines
Chas. C. McChord, Interstate Commerce Commission
F. W. Houk, Commissioner of Labor, Minnesota
Dr. Lucian W. Chaney, U. S. Department of Commerce and Labor
H. M. Wilson, Bureau of Mines
Dr. M. J. Shields, National Red Cross
C. W. Price, Wisconsin Industrial Commission
James T. McCleary, American Iron and Steel Institute
John Kirby, Jr., National Association of Manufacturers
R. C. Richards, Chicago & Northwestern Railway
C. L. Close, United States Steel Corp. Safety Committee
F. C. Schwedtman, National Association of Manufacturers
David Van Schaack, Aetna Life Insurance Co.
R. J. Young, Illinois Steel Co.
L. R. Palmer, Association of Iron and Steel Electrical Engineers

In compliance with the instructions contained in the resolution, this committee met on October 4, 1912, and elected the following officers: chairman, F. C. Schwedtman; vice chairman, L. R. Palmer; secretary, Lucian W. Chaney. This was the first step in the organization of what is now the National Safety Council—a lusty foster-child of which the Association is indeed proud.

It is interesting to note that it was the engineer who launched the national safety movement. The resolution previously quoted—often termed the Magna Carta of the National Safety Council—was written by Gano Dunn, one of America's foremost engineers. It has fallen largely upon the engineers of our industries to carry on the work of the safety movement.



Today's blast furnaces, producing up to 2000 or more tons per day and highly mechanized, are in marked contrast to those of the turn of the century, which were barrow-filled and produced 200 or 300 tons per day.

EARLY GROWTH

Within the next few years, membership of the Association became representative of its section of the iron and steel industry. In 1910, by-laws were revised to permit associate memberships, including representatives from suppliers of equipment. This was a further development of the idea of co-operation and led to increased interchange of ideas and engineering data, with rapid advances in the design of steel plant equipment. An unusual example of this co-operation is evidenced by a paper, "Electrically Driven Reversing Mills," prepared in 1924 for an Association program by J. D. Wright (General Electric), R. W. Davis (Allis-Chalmers) and O. H. Needham (Westinghouse).

As the value of Association activities became apparent, district sections were established: Pittsburgh in 1914, Chicago in 1915, Cleveland and Philadelphia in 1916, Birmingham in 1919, Detroit in 1938, Buffalo in 1944, Youngstown in 1953, San Francisco, Los Angeles and St. Louis in 1954 and Utah in 1956. Each of these sections now holds evening meetings each month through the fall, winter and spring, with occasional inspection trips to plants in their respective areas. District sections are self-governing within the general framework of the Association's constitution and by-laws.

With the growth of membership, interest developed in fields other than electrical. A combustion division was formed in 1921, a lubrication division in 1930, a mechanical division in 1932, an operating practice division in 1938 and a rolling mill division in 1943. National programs are made up with the various sessions devoted to these divisions. The growth of these engineering divisions gradually rendered the original name of the Association obsolete. In 1928 it was suggested that the word "electrical" be dropped but it was not until 1936 that the name was changed to Association of Iron and Steel Engineers.

For the first ten years of its existence, Association activities were planned and carried out entirely by the members themselves, but growth made this work burdensome. This was probably at the root of overtures made in 1914 to merge with the American Institute of Electrical Engineers. The proposal aroused little enthusiasm, however, and so, in 1917, finances permitting, a full-time manager was employed—the beginning of a permanent staff. This man was John F. Kelly, a former employee in the electrical department of National Tube Company at McKeesport, Pa.

Mr. Kelly brought to the job a combination of vision, sales ability and energy that brought the Association through the many vicissitudes of its early life and established it as a going concern. The depression of the thirties contributed to the difficulties of his job. Not to be overlooked is the valuable assistance given by A. H. ("Pop") Swartz in the early days of the organization.

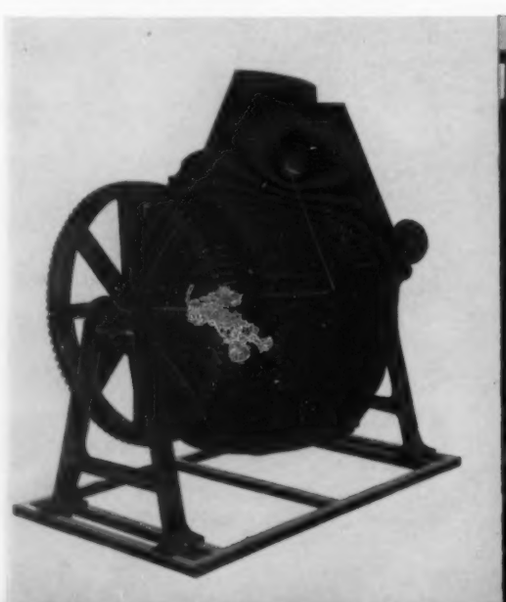
Following the death of Mr. Kelly in 1934, T. B. Little, who had been a member of the Association staff for seven years, served one year as acting managing director.

In 1936, Brent Wiley was appointed managing director. A graduate of Rose Polytechnic Institute in electrical engineering, Mr. Wiley first worked for Carnegie Steel Co. at the Ohio and Homestead works. In 1904 he went with Wellman-Seaver-Morgan Co., and in 1906 joined Westinghouse Electric and Manufacturing Co., where he spent the next 25 years in close contact with electrification in the steel industry.

During the ten years of his management, the Association developed materially in membership and strength, and broadened considerably the scope of its activities. Two district sections were added and membership reached 3000.

When Mr. Wiley retired in 1945 because of ill health, T. J. Ess, the present managing director, was elected. Following graduation from Carnegie Institute of Technology in mechanical engineering, Mr. Ess spent 15 years with Republic Steel Corp. and its predecessors, Central Steel Co. and Central Alloy Steel Corp. in maintenance, power and combustion work. In 1938 he joined the Association staff in an editorial capacity and later assumed general supervisory work.

Mr. Ess authored the "modern series" of monographs published by the Association, as well as many other articles in the *Iron and Steel Engineer*. During his tenure, five new district sections have been established and membership more than doubled.



The steel industry really began 100 years ago with the development by Henry Bessemer and William Kelly of the pneumatic converter. Kelly's first commercial converter (far left) is now in Smithsonian Institute. Converters now in use turn out 25 to 30-ton heats. Oxygen-blown converters are now causing a revival of the pneumatic process of steelmaking.

American Iron and Steel Institute
150 East Forty-Second Street
New York 17, N.Y. May 27, 1957

GEORGE A. ROSE
SECRETARY

Mr. T. J. Ess, Managing Director
Association of Iron & Steel Engineers
1010 Empire Building
Pittsburgh, Pennsylvania

Dear Mr. Ess:

The Board of Directors of American Iron and Steel Institute, at a meeting held on May 22, 1957, expressed a desire to congratulate the Association of Iron and Steel Engineers on the Celebration of its 50th Anniversary.

Being aware of the great service of the Association to its members, the iron and steel industry and the United States of America during its first half-century, the Institute Board took advantage of the opportunity to adopt, unanimously, the following resolution.

RESOLVED that the Board of Directors of American Iron and Steel Institute, at its Annual Meeting held on May 22, 1957, acting on behalf of the Institute's entire membership, hereby extends its sincere and warmest congratulations to the Association of Iron and Steel Engineers on the occasion of the Association's celebration of its 50th Anniversary, acknowledging the services of the Association to its members and to the iron and steel industry, through uncounted contributions to improvements in the art and science of iron and steel making, and expressing its confidence that the Association will continue its outstanding record of achievement.

Sincerely yours,

Secretary.

STEEL CENTENNIAL 1857 1957

John F. Kelly
1917–1934

T. B. Little
1935

AISE MANAGING DIRECTORS

Brent Wiley
1936–1945

T. J. Ess
1946–

Perhaps the simplest presentation of Association activities can be made by a listing of the men who have served as president, with the activities of their terms, a few of the principal subjects covered by their programs and mention of a few papers from these programs. Such a list brings out names of many men who have contributed greatly to AISE activities. It also emphasizes that many subjects of great interest today were under discussion many years ago.

CHRONOLOGY

James Farrington 1907–08

▲ . . . . founder of the Association of Iron and Steel Engineers . . . . annual meetings in Pittsburgh (Oct. 9–10, 1907, Engineers' Society of Western Pennsylvania) and in Philadelphia (June 24–25, 1908, Engineers Club of Philadelphia) . . . . inspection trips to Westinghouse Electric & Mfg. Co. (1907) and Electric Storage Battery Co. (1908) . . . . *standardization; gas engine generators; arc lights; steam turbines; insulation; lightning protection; motor control; d-c motors; storage batteries; centrifugal compressors* . . . . "Electric Equipment in Rolling Mills" by Brent Wiley . . . . "Auxiliary Control and Automatic Acceleration of Electric Motors" by E. W. Yearsley . . . . "Mill Motors" by Gano Dunn . . . .

John C. Reed 1909

▲ . . . . annual convention June 23–26 in Buffalo, Hotel Iroquois . . . . technical meeting October 20–22 in Pittsburgh, Hotel Schenley . . . . *crane specifications; safety; electric power for steel mills; controllers and starters; steam condensers; low pressure turbines* . . . . "Production of Steel and Iron in the Electric Furnace" by E. W. Yearsley . . . . "Some Important Phases of Electric Power for Steel Mills" by C. F. Scott . . . . "Low Pressure Turbines in Steel Plants" by R. C. Muir . . . . "Flaming Arc Lamps" by C. J. Toerring . . . . "Low Speed Motors vs Motors in Series" by R. B. Treat . . . . "Controllers and Motor Starters" by Lynde Bradley . . . .

1910 THRU 1915

F. P. Townsend 1910

▲ . . . . annual convention October 17–20 in Pittsburgh, Hotel Schenley . . . . *safety; lighting; crane specifications; turbines; motor control; liquid rheostats* . . . . "First Cost and Operating Expenses of Mixed vs Exclusively Alternating Systems in Steel Mills" by Gano Dunn . . . . "Liquid Rheostats for Industrial Purposes" by Wilfred Sykes . . . . "Safety in the Design of Standard Apparatus" by C. Pirtle . . . .

C. W. Parkhurst 1913

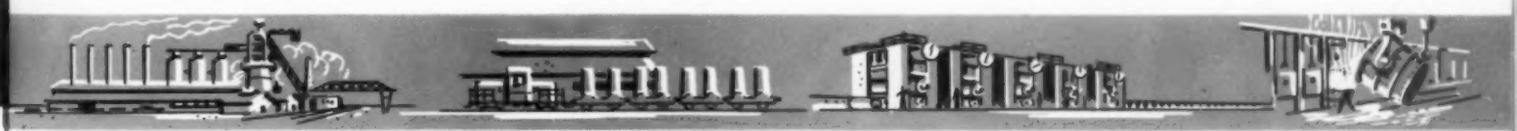
▲ . . . . annual convention September 22–27 in New York, Hotel McAlpin . . . . *carbon brushes; standardization; gearing; switching devices; lifting magnets* . . . . "Variable Speed Drives for Main Rolls" by K. A. Pauly . . . . "Present Status of Motor Drives for Main Rolls" by Brent Wiley . . . . "Control Characteristics of Motors" by M. A. Whiting . . . . "Herringbone Gears for Steel Mills" by P. C. Day . . .

L. R. Palmer 1911

▲ . . . . annual convention September 25–29 in New York, Hotel Imperial . . . . *safety; lighting; cranes; transformers; controls; lubrication* . . . . "Cost and Efficiency of A-c vs D-c Motors for Steel Mill Auxiliaries" by B. R. Shover and E. J. Cheney . . . . "Automatic Motor Control" by A. C. Eastwood . . . . "Electric Cranes for Steel Mill Service" by E. Friedlander . . . . "Iron and Steel Works Illumination" by C. J. Mundo . . . . "Transformers for Steel Mill Service" by H. C. Soule . .

E. Friedlander 1914

▲ . . . . Pittsburgh district section formed . . . . annual convention September 14–19 in Cleveland, Hotel Statler . . . . *synchronous condensers; magnetic control; apprenticeship* "Some Electrical Problems Practically Considered" by B. G. Lamme . . . . "Electrically Driven Reversing Mills" by Wilfred Sykes . . . . "Underground Transmission in a Steel Plant" by F. D. Egan . . . . "Machine Tool Control" by Harry W. Eastwood . . . . "Organized Safety" by L. R. Palmer . . .

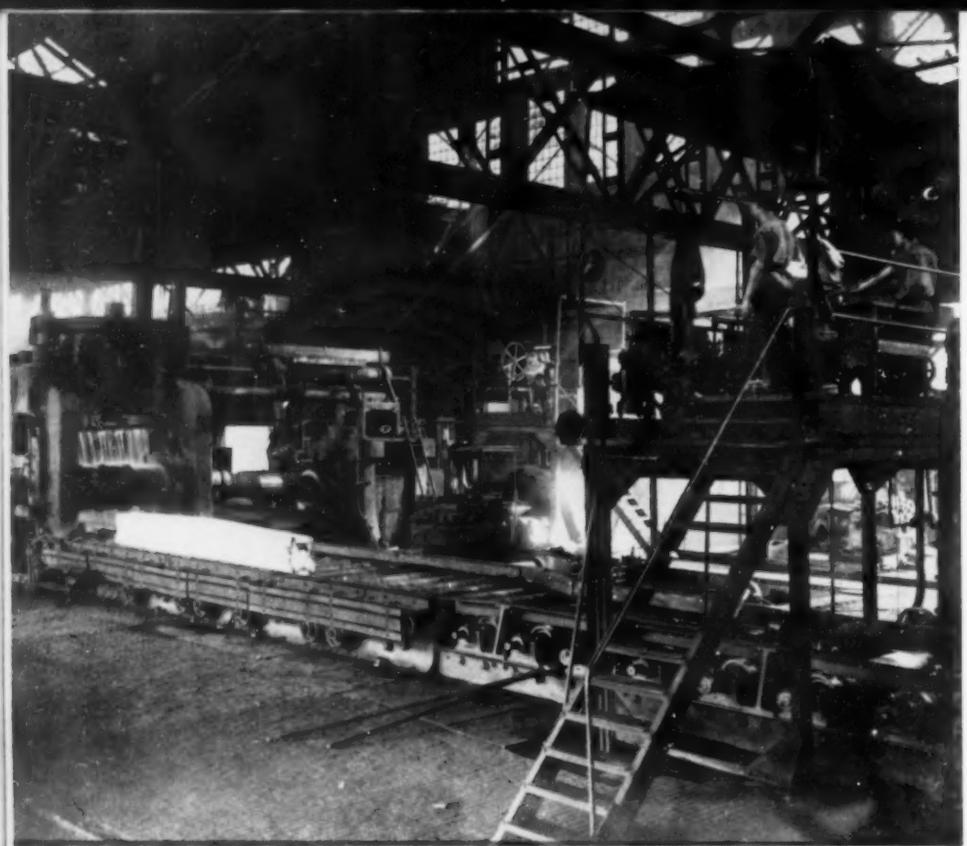


Barton R. Shover 1912

▲ . . . . annual convention September 30–October 5 in Milwaukee, Hotel Pfister . . . . national safety movement started . . . . inspection trip to Allis-Chalmers Mfg. Co. . . . . *blast furnace hoists; mixed pressure turbines; cables; transmission lines; dynamic braking* . . . . "Arc Welding" by J. F. Lincoln . . . . "Power Problems in Steel Mills" by Wilfred Sykes . . . . "Blast Furnace Skip and Bell Hoists" by A. E. Handy . . . . "Windings of Electric Machines" by H. C. Specht . . . . "Tubular Poles for Line Construction" by W. T. Snyder . . . . "Underground System of Distribution" by Wm. D. Legon . . .

O. R. Jones 1915

▲ . . . . Chicago district section formed . . . . annual convention September 8–11 in Detroit, Hotel Statler . . . . *electric furnaces; wire rope; power generation; cranes* . . . . "Protection and Control of Industrial Electric Power" by Charles P. Steinmetz . . . . "Motor-generators vs Rotary Converters" by E. Friedlander . . . . "Electrification of Steel Mills and Use of Central Station Power" by Brent Wiley and Wilfred Sykes . . . . "Repair and Depreciation of Electrical Apparatus" by G. E. Stoltz . . . . "Installation of Electrical Equipment to Comply with Requirements of Safety" by Walter Greenwood . . . .



The blooming mill above, with its hydraulic auxiliaries and open pulpit presents a striking contrast to the modern unit with its complete electrification, accurate controls and air-conditioned pulpit.

1916 THRU 1921

W. T. Snyder 1916

▲ . . . . Cleveland district section formed . . . . Philadelphia district formed . . . . annual convention September 18–22 in Chicago, Hotel La Salle . . . . *arc furnaces; crane control; power transmission* . . . . "The Unaflow Engine" by W. Trinks . . . . "Central Station Power for Steel Mills" . . . . "Control of D-c and A-c Motors on Cranes" by Paul Caldwell . . . . "Operating Characteristics of an Electric Reversing Blooming Mill" by E. S. Jeffries . . . . "Cost vs Upkeep of D-c Motors" by A. M. MacCutcheon . . . . "Modern Steel Mill Crane Specifications" by F. D. Egan . . . . "Use of Central Station Power Service in Steel Mills" by Joseph McKinley . . . . "Design of Structures for Steel Works" by C. A. Randorf . . . .

D. M. Petty 1919

▲ . . . . Birmingham district section formed . . . . inspection trip to Alabama Light & Power Co., Coosa River, Ala. . . . . annual convention September 22–26 in St. Louis, Hotel Statler . . . . first Iron & Steel Exposition . . . . *central station power rates; grounded neutral; electric locomotives; electrical department organization* . . . . "Hydraulic vs. Electric Drive for Steel Mill Auxiliaries" by R. B. Gerhardt . . . . "Main Hoists for Open Hearth Ladle Cranes" by W. W. Garrett, Jr. . . . . "Overload Protection on Cranes" by A. G. Place . . . . "Influence of Gear Ratio on Auxiliary Mill Drives" by J. E. Fries . . . . "A-c vs D-c Motors for Rolling Mill Table Drives" by W. S. Hall . . . .

F. D. Egan 1917

▲ . . . . annual convention September 10–14 in Philadelphia, Hotel Bellevue-Stratford . . . . inspection trip to Alan Wood Steel Co. . . . . first managing director hired . . . . inspection trip to Central Steel Co., Massillon, O., and United Alloy Steel Co., Canton, O. . . . . *electric skip and bell hoists; safety; standardization; arc furnaces; electric drives for reversing mills* . . . . "By-product Coke Ovens" by James Farrington . . . . "Recent Electrical Applications in the Steel Industry" by G. E. Stoltz . . . . "Heroult Arc Furnaces" by Walter C. Kennedy . . . . "Tool Steel Gears and Pinions for Mill Use" by E. S. Sawtelle . . . .

B. W. Gilson 1920

▲ . . . . inspection trip to Lukens Steel Co., Coatesville, Pa. . . . . inspection trip to Trumbell Steel Co., Warren, O. . . . . annual convention September 20–24 in New York, Hotel Pennsylvania . . . . inspection trip to Alabama Power Co., Gorgas, Ala. . . . . *steam vs electric driven mills; electric repair practices; sheet and tin mills; waste heat boilers* . . . . "Automatic Control of Reversing Rolling Mill Equipment" by E. S. Lammers, Jr. . . . . "Control of Mill Tables and Screwdowns" by W. C. Kennedy . . . . "Electric Mill Drives" by J. D. Wright . . . . "Steel Mill Electrical Repair Shop Practices" by J. A. Standring . . . .

C. A. Menk 1918

▲ . . . . no convention, war year . . . . inspection trip to Youngstown and McDonald plants, Carnegie Steel Co. . . . . *electric furnaces; steam condensers; safety; power factor correction; standardization; plate mills; electric drives for mills* . . . . "60 Cycles vs 25 Cycles in Steel Mills" by J. E. Fries . . . . "Measuring Gas Electrically" by J. C. Wilson . . . . "Practical Operation of Motor-Driven Continuous Mills" by H. C. Cronk . . . . "Rules for Safe Operation of Electric Cranes" . . . . "Some Fundamental Considerations of Power Factor Correction" by R. A. McCarty . . . . "Automatic Door Hoists for Open Hearth Furnaces" by W. H. Burr and H. A. Lewis . . . . "Standardization of Ratings of Large Rolling Mill Motors" by K. A. Pauly" . . . . "Remote Controlled Substation" by W. T. Snyder . . .

E. S. Jefferies 1921

▲ . . . . combustion division formed . . . . annual convention September 19–24 in Chicago, Hotel LaSalle . . . . *pulverized coal; boiler operation; fuel requirements; waste heat utilization; power generation; motor control and braking; standardization; rectifiers* . . . . "Frequency Problem in the Steel Industry" by B. G. Lamme . . . . "Influence of Cheap Oxygen on Economy of Fuel and Time" by E. A. W. Jefferies . . . . "Electrification of Industrial Plant Railways" by D. M. Petty . . . . "Review of Cost of Rolling Steel in Various Mills" by G. E. Stoltz . . . . "Waste Heat Utilization for Steam Generation" by G. R. McDermott . . . . "Fuel Requirements of Steel Mills" by F. E. Leahy . . . . "Anti-Friction Bearings in the Steel Mill" by A. M. MacCutcheon . . . . "Dynamic vs Mechanical Braking" by George W. Richardson . . . .

1922 THRU 1927

W. S. Hall 1922

▲ . . . . annual convention September 11–15 in Cleveland Public Auditorium . . . . *electrification of railways; stokers; fuel gases; boiler practices; remote controlled substations; internal combustion engines; turbine operation; roller bearings; frequency changers* . . . . "Efficient Burning of Fuel and Use of Waste Gases" by W. W. Pettibone . . . . "Fuel Gases and Their Use" by H. T. Watts . . . . "Improvement in Efficiency of Electric Power Supply" by Charles P. Steinmetz . . . . "Bent Tube vs Straight Tube Boilers" by Walter N. Flanagan . . . . "Judging Combustion of Gaseous Fuels from Gas Analysis" by A. G. Witting . . . . "A Review of Steel Mill Electrification" by B. G. Lamme and W. Sykes . . . . "Improved Rolling Mill Practice by Use of D-c Motors" by G. E. Stoltz . . . .

R. B. Gerhardt 1923

▲ . . . . annual convention September 24–28 in Buffalo, Hotel Statler . . . . *protection of electrical equipment; flexible couplings; foundry electrification; ore bridge control; bearings; high pressure boilers* . . . . "Electric Heating of Finishing Rolls of Sheet and Tin Mills" by Gordon Fox . . . . "Single Bucket Blast Furnace Skip Hoist Characteristics" by A. C. Cummins and A. R. Leavitt . . . . "Surface Combustion and its Application" by W. M. Hepburn . . . . "Electric Furnace Phenomena" by E. T. Moore . . . . "Economical Use of Fuel in the Steel Plant" by H. C. Seibert . . . . "Improvements in Steam Practice at Lukens Steel Co." by G. D. Spackman . . . . "General Phases of Pyrometry and Temperature Control" by O. Brewer . . . . "Electric Cranes" by F. H. Woodhull . . . . "Standardization of Engine Stops" by Walter Greenwood . . . . "Electric Transportation" by F. O. Schnure . . . .

R. S. Shoemaker 1924

▲ . . . . fuel saving conference April 2–3 in Pittsburgh, Wm. Penn Hotel . . . . annual convention September 15–20 in Pittsburgh, Duquesne Gardens . . . . *ball and roller bearings; recuperators; water treatment; electric maintenance practices; ore bridges; electric heating; welding* . . . . "The Motor that Corrects Power Factor" by W. Weischel . . . . "Control of Pressure Gas Producers" by W. P. Chandler, Jr. . . . . "Some Applications of Oxygen to Ferrous Metallurgy" by F. W. Davis . . . . "Mechanical and Electrical Analysis of 40-inch Blooming Mill Screwdown" by F. D. Egan . . . . "Electrically Driven Reversing Mills" by J. D. Wright, R. W. Davis and O. H. Needham . . . . "Adjustable Speed Drives for Rolling Mills" by L. A. Umansky . . . . "The Slagging Producer in Steel Works" by K. Huessener . . . . "Power in the Iron and Steel Industry" by Barton R. Shover . . . . "Engine vs. Motor Drive for Reversing Mill" by C. H. Hunt . . . .

A. C. Cummins 1925

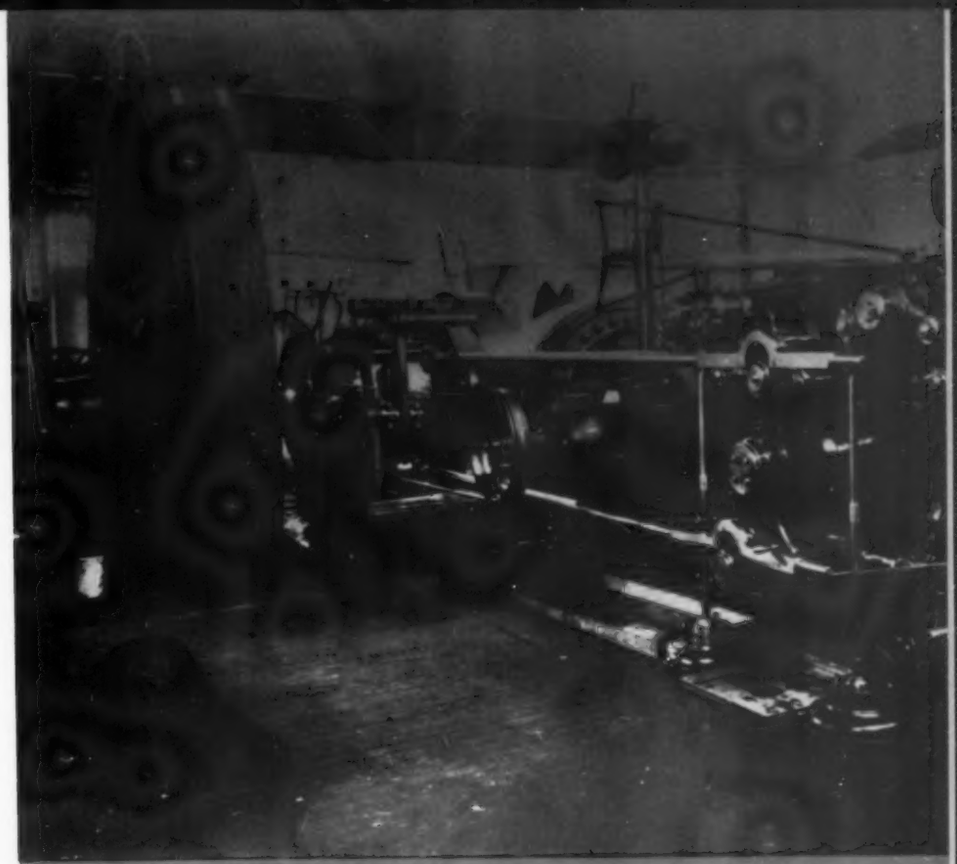
▲ . . . . fuel savings conference May 13–14 in Pittsburgh, Wm. Penn Hotel . . . . annual convention September 14–19 in Philadelphia, Benjamin Franklin Hotel . . . . *synchronous motors; gearing; power generation; combustion control; electric heating and melting furnaces* . . . . "Factors Involved in the Selection of Direct-connected and Geared Main Roll Drives" by E. A. Hurme . . . . "The Automatic Blast Furnace" by Frank W. Cramer . . . . "The Static Condenser on Steel Mill Loads" by R. W. Dudley . . . . "Electrically Heated Soaking Pits" by T. G. Bailey . . . . . "Insulation of Hot Surfaces and Furnace Walls" by L. B. McMillan . . . . "Application of Blast Furnace Gas and Air For Blowing a Gas Producer" by G. R. McDermott . . . .

G. H. Schaeffer 1926

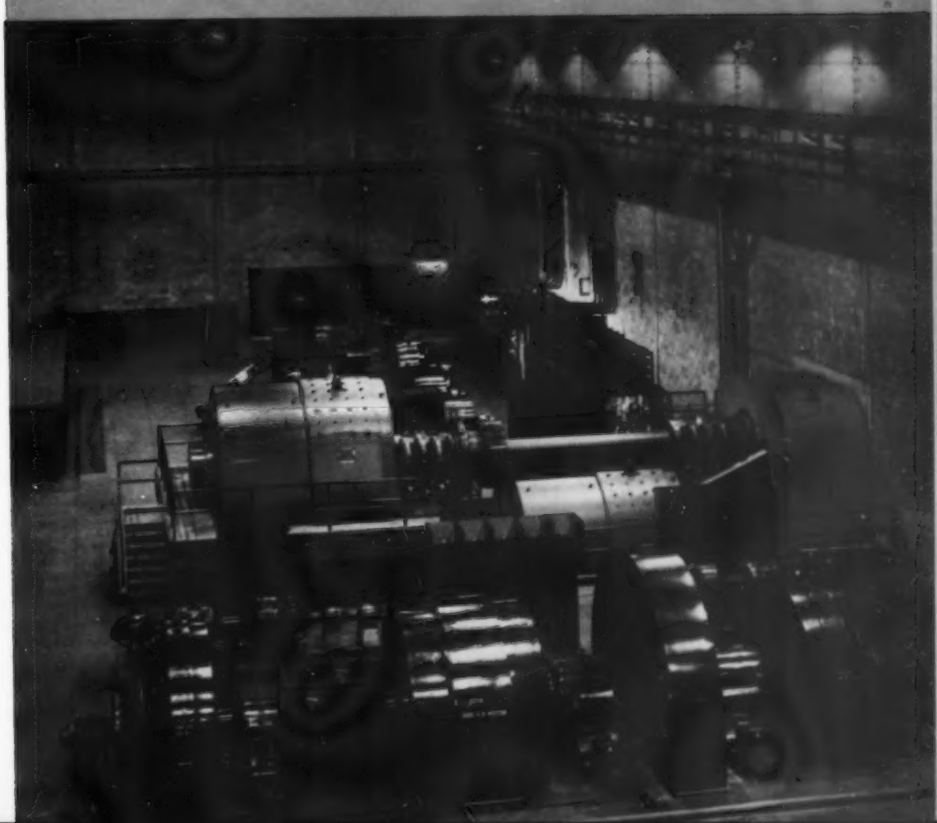
▲ . . . . safety congress March 10–11 in Pittsburgh, Wm. Penn Hotel . . . . annual convention June 7–11 in Chicago, Hotel Sherman . . . . *electric heating; anti-friction bearings; lightning protection; safe operation of cranes; frequency changers; material handling; refractories* . . . . "Electrically Heated Hot Top Ingots" by F. C. Watson . . . . "Strip Steel and Mills for its Production" by Noble Jones . . . . "Gas Producer Operation" by F. E. Leahy . . . . "Economies of Steel Plant Railroad Electrification" by O. Needham and D. C. Hershberger . . . . "Electrification and Simplification—Their Effect upon the Foundry's Future" by L. W. Egan . . . . "Magnetic Control for Steel Mill Auxiliaries" by H. H. Angel . . . . "Strength of Gear Teeth" by E. Kieft . . . . "The Flat Suspended Open Hearth Roof" by W. J. Harper . . . .

S. S. Wales 1927

▲ . . . . annual convention June 13–18 in Pittsburgh, Pittsburgh Athletic Association Annex . . . . inspection trip to Munhall works, Carnegie Steel Co. . . . . *roller bearings for roll necks; turbines; safety; synchronous motors; power conversion equipment; illumination; new electrical installations* . . . . "Trend of Recent Boiler Installations in Steel Works" by W. B. Skinkle . . . . "Arc Welded Structural Steel Buildings" by C. G. Watson . . . . "Electrification of Sheet Mills" by J. S. Murray . . . . "Bearings for Use in Rolling Mills" by C. J. Klein . . . . "Centrifugal Compressors" by Batt L. Spain . . . . "Speed Regulation of Main Roll Drives" by L. A. Umansky . . . . "Replacement of Obsolete Equipment by A. J. Standing . . . . "Safe Practices in Connection with the Operation of High Tension Power" by T. E. Hughes . . . . "Combustion Control for Industrial Furnaces" by F. J. Ryan . . . .



The change in motive power from steam to electricity simplified the problems of rolling mill design and operation, and provided the flexibility necessary for successful continuous rolling.



1928 THRU 1933

A. J. Standing 1928

▲ . . . . fuel conference March 29 in Pittsburgh, Wm. Penn Hotel . . . . inspection trip to Edgar Thomson works, Carnegie Steel Co. . . . . welding conference April 20 in Cleveland . . . . annual convention June 25–28 in Chicago, Hotel Stevens . . . . inspection trip to Gary works, Illinois Steel Co. . . . . *air heaters; new installations; safety; welding; grounding; lubrication; steam generation; transmission; carbon brushes; electric precipitators; open hearth control* . . . . "Adjustable Speed Main Roll Drives" by M. H. Morgan . . . . "Discussion of Elements Entering into the Cost of Producing Power" by W. B. Skinkle . . . . "Recording and Controlling Instruments in the Iron and Steel Industry" by C. C. Eagle and R. M. Walker . . . . "Ward-Leonard Control on Blast Furnace Skip Hoists" by E. Anderson . . . .

C. S. Proudfoot 1929

▲ . . . . combustion conference January 23–24 in Pittsburgh, Wm. Penn Hotel . . . . annual convention June 17–21 in Pittsburgh, Wm. Penn Hotel . . . . inspection trip to Aliquippa plant, Jones & Laughlin Steel Corp. . . . . welding conference November 13–14 in Pittsburgh, Wm. Penn Hotel . . . . *roller bearings; blast furnace theory and practice; smoke abatement; safety; steam generation; welding; water treatment; gas producers; rolling mill drives* . . . . "Time-Current Control for D-c Motors" by D. C. Wright . . . . "Application of Pulverized Coal to Metallurgical Furnaces" by W. O. Renkin . . . . "Short Circuit Study of a Steel Plant Power Transmission System" by R. M. Hussey . . . . "Smoke Abatement in Industry" by Martin J. Conway . . . . "Deterioration and Maintenance of Oil" by C. W. Bryden . . . . "Power Economy" R. J. Fuller . . . .

F. W. Cramer 1930

▲ . . . . spring conference February 7 in Youngstown, Ohio Hotel . . . . annual convention June 16–20 in Buffalo, Hotel Statler . . . . lubrication division formed . . . . *bearings; cranes; electric galvanizing; electric heating; limit switches; new electrical installations; illumination* . . . . "Rolling Mill Analysis" by E. Kieft . . . . "Theory of Rolling of Plastic Materials" by F. G. Gasche . . . . "Tapered Roller Bearings and Their Applicability to Steel Plant Equipment" by F. Waldorf . . . . "Crane Track Wheels and Crane Runways" by R. J. Harry . . . . "The Use of Mixed Gas in Open Hearth Furnaces" by George E. Rose and F. M. Washburn . . . . "Flow Measurement of Coke Oven Gas" by J. M. Spitzglass . . . . "Modern Reversing Mill Drives" by R. H. Wright . . . . "Measuring of Roll Pressures" by F. H. Buhlman . . . .

F. O. Schnure 1931

▲ . . . . welding conference January 21–22 in Pittsburgh, Wm. Penn Hotel . . . . lubrication conference February 18 in Pittsburgh, Wm. Penn Hotel . . . . annual convention June 15–19 in Cleveland Public Auditorium . . . . inspection trip to Goodyear Tire & Rubber Co., Akron, O. . . . . *electrical department organization; open hearth controls; air filters; fuel oil; brakes; table roller drives; circuit breakers; bearings; electronic tubes* . . . . "Group vs Individual Driven Rolling Mill Stands" by R. H. Ellis . . . . "Power Consumption Tests on Blooming and Bar Mills" by F. Waldorf . . . . "A Comparison of A-c and D-c Motors for Auxiliary Drives" by Gordon Fox . . . . "Plastic and Elastic Deformation" by E. Kieft . . . . "The Coreless Induction Furnace" by E. F. Northrup . . . . "Twin Motor Drive" by R. H. Wright and H. E. Stokes . . . . "Motor and Control Equipment for Cold Strip Mill Drives" by F. Mohler . . . .

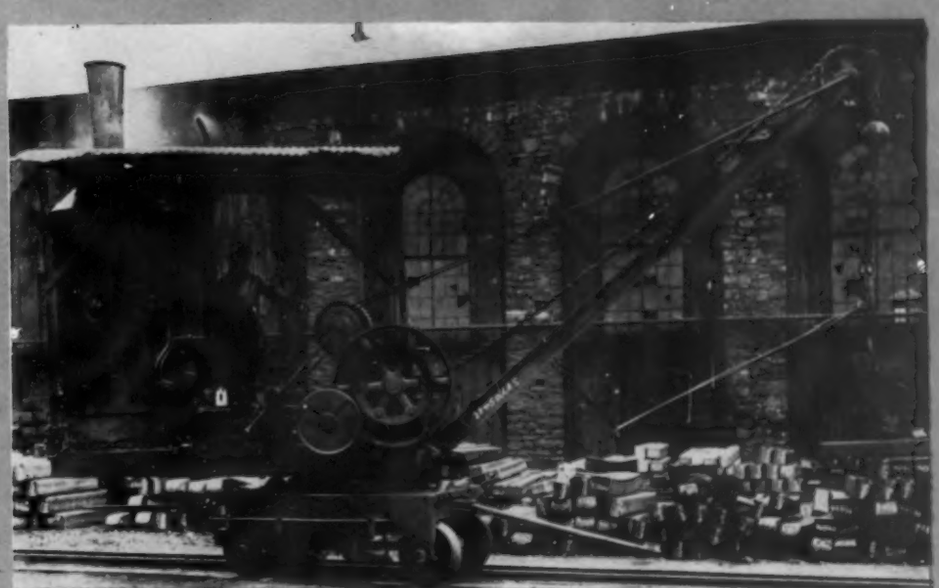
J. J. Booth 1932

▲ . . . . spring conference March 24 in Youngstown, Ohio Hotel . . . . annual convention June 20–23 in Pittsburgh, Wm. Penn Hotel . . . . *mechanical division formed . . . . electric controls; open hearth controls; ladle cranes; mechanized sheet mills; boilers; lubrication* . . . . "Development of Hot Metal Mixers" by L. E. Allen . . . . "Roll Neck Lubricants and Lubrication" by W. D. Hodson . . . . "Determination of Motor Capacity for Main Roll Drives" by H. A. Winne . . . . "Behavior of Steel at Forging Temperatures with Respect to Scaling Losses" by D. W. Murphy . . . . "Influence of Modern Electric Equipment Design on Brush Performance" by W. Siebenmorgen . . . . "Better Construction and Better Maintenance by the Use of Alloy Steels" by E. C. Smith . . . . "Mercury Arc Rectifiers" by W. E. Gutzwiler and R. W. Davis . . . .

J. D. Donovan 1933

▲ . . . . annual convention October 17–19 in Pittsburgh, Wm. Penn Hotel . . . . inspection trips to Brackenridge works, Allegheny Steel Co., and Vandergrift works, American Sheet & Tinplate Co. . . . . *lubrication; bearings; gearing; welding; heating furnaces; electrical precipitators* . . . . "Cold Rolling Practices" by Lloyd Jones . . . . "Recent Developments in the Rolling of Sheets and Strip" by Stephen Badlam . . . . "Practical Methods for Inductively Heating Solids" by E. F. Northrup . . . . "Locomotives for Shifting Purposes in Industrial Plants" by D. M. Petty . . . . "Heat Transfer to the Open Hearth Bath" by W. C. Buell, Jr. . . . . "Hot Galvanizing of Sheets" by Nelson E. Cook . . . . "Electrical Features of Modern Cold Roll Strip Mills" by A. F. Kenyon . . . . "Electric Drives for Flying Shears" by L. A. Umansky . . . .

Improved material handling methods have contributed greatly to the economy of steel production and processing.



1934 THRU 1939

W. E. Miller 1934

▲ . . . . spring conference April 11–12 in Youngstown, Ohio Hotel . . . . annual convention September 18–20 in Cleveland Public Auditorium . . . . *open hearth control; bearings; lubrication; precision rolling mills; refractories; welding; turbines; cranes; lightning protection* . . . . "Heat Resisting Castings" by F. A. Fahrenwald . . . . "Tube Type Annealing Furnaces" by Lee Wilson . . . . "Blast Cleaning of Steel" by W. A. Rosenberger . . . . "Social and Industrial Relations between Employer and Employee" by T. M. Girdler . . . . "Progress of Centralized Lubrication in the Steel Industry" by A. J. Jennings . . . . "Mechanical Billet Chipping" by G. W. Lentz . . . . "Development of the Modern Blast Furnace" by A. G. McKee . . . . "Individual Motor Drives for Runout Tables and Coilers" by F. E. Harrell and C. V. Gregory . . . . "Insulating Firebrick Applications in Steel Heating Furnaces" by M. J. Terman . . . . "Blast Cleaning of Steel" by W. A. Rosenberger . . . .

W. H. Burr 1935

▲ . . . . spring conference April 24–25 in Youngstown, Ohio Hotel . . . . annual convention September 24–26 in Pittsburgh, Wm. Penn Hotel . . . . inspection trip to Weirton Steel Co. . . . . *automatic preset screwdown control; composition bearings; diesel locomotives; continuous strip mills* . . . . "High Temperature Conveyors for Heating Furnaces" by W. E. Blythe . . . . "Roller Bearing Applications in Strip and Rod Mills" by S. M. Weckstein . . . . "Flat Rolling of Steel" by C. L. McGranahan . . . . "Open Hearth Furnace Operation" by E. H. Schwartz and George E. Rose . . . . "Lubricant Specifications" by O. L. Maag . . . . "Roof Temperature Control" by M. J. Bradley . . . . "Use of the Venturi Port" by George L. Danforth, Jr. . . . . "Designing for Lubrication" by Charles R. Hand . . . .

G. R. Carroll 1936

▲ . . . . spring conference April 22–23 in Youngstown, Ohio Hotel . . . . inspection trip to McDonald works, Carnegie-Illinois Steel Corp. . . . . annual convention September 22–25 in Detroit, Hotel Statler . . . . inspection trips to Great Lakes Steel Corp. and Ford Motor Co. . . . . *refractories; lubrication; rolling pressures; strip mills; welding; strip finishing; cold forming; recuperators* . . . . "Material Handling Facilities for Hot and Cold Strip Mills" by F. M. Gillies . . . . "A Study of Blast Furnace Charging" by Gordon Fox . . . . "Descaling Steel Hydraulically" by J. E. Holveck . . . . "Mill Motor and Motor Room Ventilation" by H. H. Angel and C. B. Huston . . . . "Analysis of Electric Power Costs" by J. W. Bates . . . . "Applying Synchronous Motors to Main Roll Mill Drives" by L. A. Umansky . . . .

H. G. R. Bennett 1937

▲ . . . . winter meeting February 25 in Youngstown, Ohio Hotel . . . . inspection trip to Youngstown Sheet & Tube Co. . . . . spring conference April 28–29 in Buffalo, Hotel Statler . . . . inspection trip to Lackawanna plant, Bethlehem Steel Co. . . . . annual convention September 28–October 1 in Chicago, Stevens Hotel . . . . inspection trips to Gary Sheet & Tin Division, Carnegie-Illinois Steel Corp. and Inland Steel Co. . . . . *continuous strip mills; lubrication; refractories; turbines; flood protection and rehabilitation; heating furnace control* . . . . "Organization and Functions of a Maintenance Department" by T. E. Hughes and J. J. Booth . . . . "Combination Fired Boilers" by C. H. Williams . . . . "Furnace Atmosphere" by A. J. Fisher . . . . "Ward-Leonard Control for Blooming and Slabbing Mill Auxiliaries" by W. B. Snyder . . . . "Mechanical Developments in Cold Rolled Strip Mills" by John L. Young . . . . "Electrical Operation of Cold Strip Mills" by A. F. Kenyon . . . .

L. F. Coffin 1938

▲ . . . . Detroit district section established . . . . operating practice division formed . . . . winter meeting March 21 in Youngstown, Ohio Hotel . . . . inspection trip to Republic Steel Corp. . . . . spring conference April 28–29 in Baltimore, Lord Baltimore Hotel . . . . inspection trip to Sparrows Point plant, Bethlehem Steel Co. . . . . annual convention September 27–30 in Cleveland Public Auditorium . . . . inspection trips to Republic Steel Corp. and Fisher Body plant, General Motors Corp. . . . . *continuous strip mills; rectifiers; circular soaking pits; cables; lubrication* . . . . "Flow of Metal Between Rolls" by Louis Moses . . . . "Power Requirements of a 56-in. Hot Strip Mill" by F. O. Schnure and R. H. Wright . . . . "Design of Modern Blooming-Slabbing Mills" by Lorenz Iverson . . . . "Design and Operation of a Modern Blast Furnace" by J. C. Barrett . . . .

C. C. Wales 1939

▲ . . . . spring conference March 27–28 in Birmingham, Hotel Tutwiler . . . . inspection trips to Tennessee Coal, Iron and Railroad Co. and American Cast Iron Pipe Co. . . . . annual convention September 26–29 in Pittsburgh, Hotel Wm. Penn . . . . inspection trips to Irvin and Edgar Thomson works, Carnegie-Illinois Steel Corp. . . . . *wide strip rolling and processing; heating rates for steel* . . . . "Developments in Electro-Tinplating of Strip Steel" by D. C. Bakewell . . . . "Gage Control for Cold Strip Mills" by F. Mohler . . . . "Practical Aspects of Steel Making" by C. L. Altenburger . . . . "Modernization of Existing Open Hearth Equipment" by George L. Danforth, Jr. . . . . "Power Requirements of Cold Strip Mills" by A. F. Kenyon . . . .

1940 THRU 1945

J. A. Clauss 1940

▲ . . . . spring conference April 1–2 in Cincinnati, Netherland-Plaza Hotel . . . . inspection trips to American Rolling Mill Co. and Andrews Steel Co. . . . . annual convention September 25–27 in Chicago, Stevens Hotel . . . . inspection trips to Wisconsin Steel Works and Youngstown Sheet & Tube Co. . . . . *cranes; regulators; continuous strip annealing; gearing; water treatment; wide strip mills and finishing equipment* . . . . "Improvements in Open Hearth Design and Operation" by L. F. Reinartz . . . . "Coke and By-Product Yields from Various Coals" by Joel D. Davis . . . . "Modern Arc Furnace Design and Practice" by H. F. Walther . . . . "Blast Furnace Rehabilitation" by J. H. Slater . . . . "Factors of Open Hearth Design and Practice" by W. C. Buell, Jr. . . . . Hot Scarfing of Billets, Blooms and Slabs" by E. A. Doyle . . . .

W. A. Perry 1941

▲ . . . . spring conference April 28 in Youngstown, Ohio Hotel . . . . inspection trip to Sharon Steel Corp. . . . . annual convention September 23–25 in Cleveland Public Auditorium . . . . inspection trip to Otis Steel Co. . . . . "The Modern Strip Mill" published . . . . *water requirements, distribution and treatment; regulating devices; comparison of soaking pit designs; arc furnaces; crane girder research; bearings; increasing production from existing facilities; sintering; welding* . . . . "Economics of the Electric Furnace for Steel Making" by H. E. Phelps . . . . "Sintering of Iron Ore" by E. W. Shallock . . . . "Modern Design of Annealing Covers" by Lee Wilson . . . . "Scarfing Hign Carbon and Alloy Steels" by G. D. Winlack . . . . "The Temper Mill" by T. B. Montgomery . . . . "Effect of Rate of Operation in the Coke Plant" by B. J. C. van der Hoeven . . . .

T. E. Hughes 1942

▲ . . . . spring conference May 11–12 in Hamilton, Ontario, Royal Connaught Hotel . . . . inspection trips to Steel Company of Canada, Ltd., and Dominion Foundries and Steel, Ltd. . . . . annual convention September 22–24 in Pittsburgh, Hotel Wm. Penn . . . . *plant protection; increasing production; war-time substitutes; electrical controls* . . . . "Design, Operation and Construction of a Bessemer Converting Mill" by D. R. Loughrey . . . . "Mercury-Arc Rectifier vs Motor-Generator" by L. R. Milburn . . . . "Blast Furnace Gas Conditioning" by Owen R. Rice . . . . "Properties of Blast Furnace Cokes" by H. H. Lowry and M. A. Mayers . . . . "Rolling Pressures in Strip Mills" by M. D. Stone and J. I. Greenberger . . . . "Relation of Flame Character to Open Hearth Operation" by A. J. Fisher . . . . "The Blast Furnace Skip Hoist" by Gordon Fox . . . .

F. E. Flynn 1943

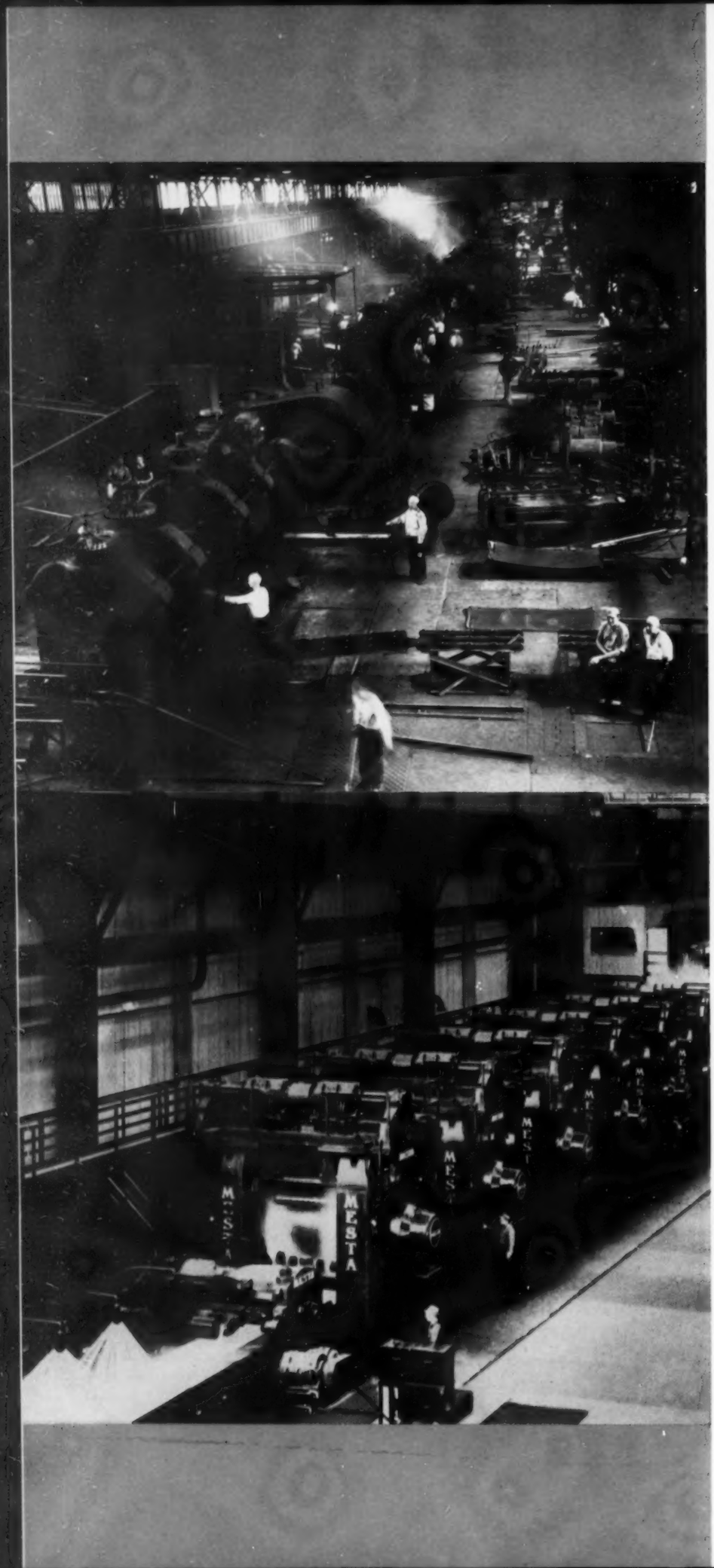
▲ . . . . spring conference May 10 in Pittsburgh, Hotel Wm. Penn . . . . annual convention September 27–30 in Pittsburgh, Hotel Wm. Penn . . . . rolling mill division established . . . . *electrolytic tinning; conservation of materials; wartime substitutes; rolling mills* . . . . "Bar Mills and Bar Mill Roll Design" by Ross E. Beynon . . . . "Reclaimed Sewage Water for Industrial Uses" by L. F. Coffin . . . . "Design of Blooming and Slabbing Mill Elements" by H. H. Talbot . . . . "The Modern Soaking Pit and Blooming Mills" by T. J. Ess . . . . "The Fable of Easy Steel" by Hiland G. Batcheller . . . . "Blowing Rates of Various Blast Furnaces" by E. L. Clair . . . . "Modern Trends in Blast Furnace Design" by Frank Janecek . . .

Chas. L. McGranahan 1944

▲ . . . . spring conference in May 8–9 in Pittsburgh, Hotel Wm. Penn . . . . annual convention September 25–27 in Pittsburgh, Hotel Wm. Penn . . . . Buffalo district section established . . . . *war time substitutes; maintenance; plate mills; cleaning of steel; use of by-product gases; rotating regulators; cranes; rolling mills* . . . . "The Modern Arc Furnace" by T. J. Ess . . . . "The Rolling of Semi-Finished Steel" by Ross E. Beynon . . . . "Shearing Flat Rolled Steel" by F. E. Flynn and D. A. MacArthur . . . . "Gas Turbines for Blast Furnace Blowers" by Paul R. Sidler . . . . "Alloy Steels for Maintenance" by J. A. Rosa . . . . "Emergency Loading of Electrical Equipment" by Fraser Jeffrey . . . . "Main Roll Drives for Merchant-Bar and Rod Mills" by W. B. Snyder . . . . "The Electronic Frequency Changer" by F. W. Cramer, L. W. Morton and A. G. Darling . . . .

J. L. Miller 1945

▲ . . . . rolling mill meeting May 14 in Pittsburgh, Wm. Penn Hotel . . . . annual convention held as series of regional meetings: Sept. 17, Birmingham; Sept. 24, Detroit; Sept. 26, Pittsburgh; Oct. 1, Chicago; Oct. 3, Cleveland; Oct. 6, Philadelphia . . . . *lubrication; heating furnaces; stream pollution; fuel conservation; tube production* . . . . "Influence of the Charge upon Open Hearth Furnaces" by H. F. Lesso and R. W. McCann . . . . "Some Characteristics of Blast Furnace Gas" by Owen R. Rice . . . . "Blast Furnace Operation under Elevated Top Pressure" by Frank Janecek . . . . "The Sendzimir Precision Cold Strip Mill" by T. Sendzimir . . . . "Rail Mills and Rail Mill Roll Design" by Ross E. Beynon . . . . "Development and Application of Twin Motor Drive" by G. E. Stoltz . . . .



Hand sheet mills (top) produced from one-half ton to three tons per hour. A modern continuous strip mill (bottom) can roll more than 250 tons an hour, with greater uniformity of product. The modern strip mill is a development of the last 30 years.

1946 THRU 1951

Freeman H. Dyke 1946

▲ . . . . spring conference May 5–7 in Chicago, Congress Hotel . . . . inspection trip to Republic Steel Corp., South Chicago . . . . annual convention October 1–4 in Cleveland Public Auditorium . . . . *steel conditioning; adjustable speed drives; bearings; material handling; refractories* . . . . "Rapid Heating of Steels" by F. O. Hess . . . . "The Modern Blast Furnace" by T. J. Ess . . . . "Continuous Strip Annealing" by E. J. Seabold . . . . "A New Method of Coil Annealing" by H. H. Armstrong and F. F. Schlitt . . . . "The Manufacture of Oxygen for Industrial Uses" by Martin J. Conway . . . . "The Art of Rolling Rounds" by Charles P. Hammond "Induction Heating" by N. R. Stansal . . . . "Some Observations on Seamless Tube Making" by Newell Hamilton . . . . "The Scheduling of Maintenance Shops" by L. E. Fuller . . . .

L. R. Milburn 1947

▲ . . . . spring conference May 26–27 in Philadelphia, Benjamin Franklin Hotel . . . . inspection trip to Lukens Steel Co., Coatesville, Pa. . . . . annual convention September 22–25 in Pittsburgh, Hotel Wm. Penn . . . . inspection trip to Homestead Works, Carnegie-Illinois Steel Corp. . . . . *all-basic open hearths; oxygen in steel production; standardization; cranes; maintenance metallurgy; automatic preset screwdown control* . . . . "Speeding Open Hearth Charging" by R. J. Harry . . . . "Oxygen-Accelerated Combustion in Open Hearth Furnaces" by E. T. W. Bailey . . . . "Depreciation of Industrial Facilities" by Charles R. Cox . . . . "Continuous vs Batch Annealing of Sheet and Strip" by T. F. Olt . . . . "Carbon Hearth Installations at Homestead" by C. J. Fleisch . . . . "A Realistic Scrap Policy" by Robert W. Wolcott . . . .

A. J. Fisher 1948

▲ . . . . spring conference April 26–27 in Buffalo, Hotel Statler . . . . inspection trip to Lackawanna plant, Bethlehem Steel Co. . . . . annual convention Sept. 28–Oct. 1 in Cleveland Public Auditorium . . . . *off-site blast furnace construction; refractories; maintenance; training methods* . . . . "Economic Factors in Canadian and United States Trade" by Robert A. Gillies . . . . "The Modern Coke Plant" by T. J. Ess . . . . "The Modern Open Hearth" by T. J. Ess . . . . "Stresses in Hot Metal Ladles" by K. E. Knudsen, W. H. Munse and B. G. Johnston . . . . "Deformation in Rolling" by George S. Mican . . . . "Developments in Continuous Butt Weld Pipe Mills" by William Rodder . . . . "Power for an Industrial Plant" by E. M. Yard and W. E. Zelley . . . . "Practical Metallurgy for the Steel Mill Engineer" by W. B. McFerrin . . . . "Chromium Plating in Maintenance Practice" by Richard M. Wick . . . . "The Art of Rolling Flats" by Charles P. Hammond . . .

C. H. Williams 1949

▲ . . . . spring conference May 2–3 in Baltimore, Lord Baltimore Hotel . . . . inspection trips to Sparrows Point plant, Bethlehem Steel Co., and Rustless Iron and Steel Division, Armco Steel Corp. . . . . annual convention October 3–6 in Pittsburgh, Hotel Wm. Penn . . . . *coal and ore preparation; water pollution; crane specifications; apprentice training; standardization; material handling* . . . . "Always More Production" by Stewart J. Cort . . . . "Static Magnetic Amplifiers for Regulating Circuits" by H. E. Larson and T. Dunnegan, Jr. . . . . "Modern Seamless Tube Mills" by William Rodder . . . . "Electric Equipment for Rolling Cold Strip at 70 mph" by William E. Miller . . . . "The Mechanical Rectifier" by Otto Jensen . . . . "Electrical Equipment for Cold Rolling and Finishing Department" by M. A. Leishman . . . . "Engineering Responsibility in the Steel Industry" by M. W. Reed . . . .

A. S. Glossbrenner 1950

▲ . . . . spring conference April 3–4 in Birmingham, Tutwiler Hotel . . . . inspection trips to Connors Steel Co. and Tennessee Coal, Iron and Railroad Co. . . . . annual convention September 26–29 in Cleveland Public Auditorium . . . . inspection trip to Lorain plant, National Tube Co. . . . . *air pollution; power distribution; grounding; standardization; carbon hearths for blast furnaces; cranes; oxygen in steelmaking; supervisory development; split wind blowing; bearings; temper mills* . . . . "Automatic Self-Centering Rolls and Pulleys" by E. T. Lorig . . . . "Economics of a 500-ton Open Hearth Furnace" by W. W. Kompart . . . . "Technical Aspects of Northern and Southern Blast Furnace Practice" by C. G. Hogberg . . . . "Inventory Time" by Harvey B. Jordan . . . . "Power for Hot Strip Mills" by A. F. Kenyon . . . .

John F. Black 1951

▲ . . . . spring conference April 30–May 1 in Detroit, Hotel Statler . . . . inspection trip to Ford Motor Co. . . . . annual convention October 1–4 in Chicago, Hotel Sherman . . . . inspection trip to Gary Sheet and Tin Division, U. S. Steel Corp. . . . . *purchased vs. plant generated power; water pollution; lighting, heating and ventilation of steel plant buildings; bearings and lubrication; sintering; jet tapping; sonic energy* . . . . "Electric Furnace or Open Hearth?" by C. F. Ramseyer . . . . "Latest Developments in Extrusion of Metals" by Erwin Loewy . . . . "The Rolling of Thin Strip" by M. D. Stone . . . . "The Axial Compressor for Blast Furnace Blowing" by W. O. Lowell . . . . "Problems in Steel Plant Administration" by H. W. Johnson . . . . "Electronics in the Steel Industry" by H. W. Poole . . . . "Comparative Economics of the Electric Furnace and Open Hearth" by H. W. McQuaid . . . . "Combustion Gas Turbines" by W. B. Wilson . . . .

Portable annealing covers (bottom) have almost entirely replaced the old batch annealing process with its heavy cast iron covers (top). Continuous strip annealing, a recent development, is now gaining acceptance, particularly for tinplate.

1952 THRU 1957

I. N. Tull 1952

▲ . . . . spring conference April 28–29 in Cincinnati, Netherland-Plaza Hotel . . . . inspection trip to Middletown plant, Armco Steel Corp. . . . . annual convention Sept. 30–Oct. 3 in Cleveland Public Auditorium . . . . *extrusion; firing and control of open hearths; crane runways; lubrication; regulating systems; air pollution; high temperature alloy; water pollution; rehabilitation of plant equipment; castable refractories; magnetic amplifiers; oxygen; painting* . . . . "Production of Steel by the Oxygen-Impingement Process" by T. E. Suess . . . . "Today's Challenge to Management" by W. W. Sebald . . . . "Open Hearth Dust Control" by Stephen Vajda . . . . "Investigation of Piercing Process by Means of Model Wax Billets" by J. L. Holmquist . . . . "Selection and Analysis of Regulating Systems for Mill Drives" by W. E. Miller and F. S. Rothe . . . . "The Extrusion of Steel" by Jacques Sejournet . . . .

John L. Young 1953

▲ . . . . Youngstown district section formed . . . . spring conference May 18–19 in Buffalo, Hotel Statler . . . . inspection trip to Steel Co. of Canada, Ltd. . . . . annual convention Sept. 28–Oct. 1 in Pittsburgh, Hotel Wm. Penn . . . . inspection trip to Pittsburgh works, Jones and Laughlin Steel Corp. . . . . *gearing; electronics; lighting; continuous annealing; air pollution; open hearth availability; direct rolling of plate; open hearth furnaces; transformers; ultrasonics* . . . . "Temperature Distribution in the Hearths of Blast Furnaces" by V. Paschkis and T. Mirsepassi . . . . "Growth Possibilities of Electric Furnace Carbon Steel" by Willard C. Wheeler . . . . "Cost Comparisons of the Open Hearth and Electric Furnace" by D. D. Moore . . . . "A New Theory of Hot Rolling" by George S. Mican . . . . "Temperature Stresses in Iron Work Rolls" by C. F. Peck, Jr., J. M. Bonetti and F. T. Mavis . . . .

E. L. Anderson 1954

▲ . . . . district sections formed in San Francisco, Los Angeles and St. Louis . . . . first western meeting February 15–17 in Los Angeles, Hotel Statler . . . . inspection trip to Kaiser Steel Corp., Fontana, Calif. . . . . spring conference May 3–5 in Philadelphia, Bellevue-Stratford Hotel . . . . inspection trip to Fairless Works, U. S. Steel Corp. . . . . annual convention Sept. 28–Oct. 1 in Cleveland Public Auditorium . . . . *extrusion; cables; blast furnace maintenance; oxygen steelmaking; painting; lubricating greases; titanium; magnetic amplifier* . . . . "Continuous Casting at Atlas Steels, Ltd." by J. F. Black . . . . "Taper vs. Straight Tread Crane Wheels" by J. A. Bell . . . . "More than Technology" by M. W. Reed . . . . "Trends in Recent Cold Mill Installations" by R. E. Noble . . . . "Economics of Replacement in the Steel Industry" by G. G. Beard . . . .

John H. Vohr 1955

▲ . . . . western meeting March 21–23 in San Francisco, St. Francis Hotel . . . . inspection trip to Pittsburgh Works, Columbia-Geneva Division, U. S. Steel Corp. . . . . spring conference April 25–27 in Detroit, Hotel Statler . . . . inspection trip to Great Lakes Steel Corp. . . . . annual convention September 26–29 in Chicago, Hotel Sherman . . . . inspection trip to Youngstown Sheet & Tube Co., Indiana Harbor Works . . . . *arc furnaces; extrusion; sintering; induction heating; split wind blowing; power systems; continuous annealing; under hearth cooling in blast furnaces; industrial television; modernization; transistors* . . . . "Increased Steel Production from Desiliconized Hot Metal" by E. C. Wright . . . . "The Oxygen Steelmaking Process" by D. O. Davis . . . . "Electrical Equipment for Auxiliary Drives of Hot Strip Mills" by S. H. Williamson . . . . "Ideal Maintenance Machine Shop Facilities" by W. J. Pearson . . . .

W. H. Collison 1956

▲ . . . . Utah district section established . . . . western meeting February 20–22 in Los Angeles, Hotel Statler . . . . inspection trip to Los Angeles plant, Bethlehem Pacific Coast Steel Corp. . . . . spring conference April 30–May 2 in Baltimore, Lord Baltimore Hotel . . . . inspection trip to Sparrows Point plant, Bethlehem Steel Co. . . . . annual convention September 25–28 in Cleveland Public Auditorium . . . . *expansion; electric furnaces; hot blast cupolas; lubricating greases; water pollution; oxygen; silicones; strip annealing; bar and rod mills* . . . . "Progress in Production" by Stewart J. Cort . . . . "Modern European Hot Blast Changing Equipment" by Herman Jansen . . . . "Nuclear Technology and the Steel Industry" by R. P. Peterson . . . . "The All-basic Open Hearth Furnace" by R. P. Heuer and M. A. Fay . . . .

J. D. O'Roark 1957

▲ . . . . 50th anniversary of the Association . . . . western meeting March 4–6 in San Francisco, St. Francis Hotel . . . . inspection trip to San Francisco plant, Bethlehem Pacific Coast Steel Corp. . . . . spring conference April 29–May 1 in Cincinnati, Netherland-Hilton Hotel . . . . inspection trip to Portsmouth plant, Detroit Steel Corp. . . . . annual convention September 23–26 in Pittsburgh, Penn-Sheraton Hotel . . . . *oxygen; rod mills; mill guides; water pollution; cranes; fire protection; continuous casting; sound control; open hearth firing* . . . . "The Planetary Hot Strip Mill" by T. Sendzimir . . . . "Selection and Economy of Blooming and Slabbing Mills" by Kurt Schlesinger . . . . "Modern Methods of Iron Ore Reduction" by H. W. McQuaid . . . . "Comparison of Regulator Characteristics" by P. W. Clark . . . .

THE foregoing outline charts a program of activities which has developed the original organization of 28 men to one international in character, with 7600 members in 31 countries, but all in a specialized field—steel. The program has purposely been held to a practical level so as to be of maximum benefit to the men of the industry. It has broadened the abilities and view points of AISE members and fostered close cooperation with their counterparts in the various steel plants and with the manufacturers of equipment and supplies.

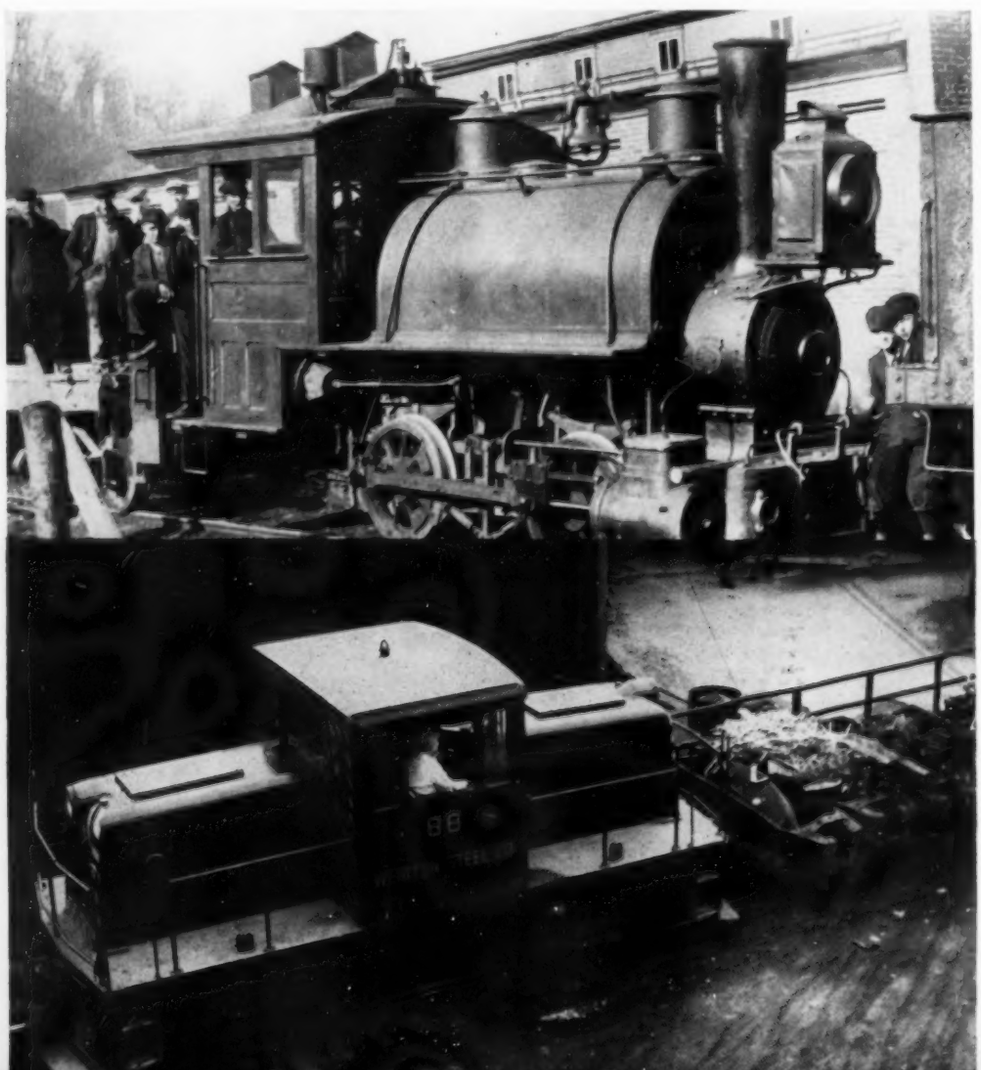
AISE promoted the application of electric motors for rolling mill drives and the broad electrification of auxiliary machines. It furthered the development and application of combustion control and instrumentation in steel plant processes. It influenced improvements in the design of equipment used in the industry and helped in the application of modern bearings and lubrication devices.

In 1924, sheet material was first rolled in multiple lengths on a commercial basis at Ashland, Ky. This mill was developed by John B. Tytus and built by American Rolling Mill Co. Two years later another mill went into operation at Columbia Steel Co. at Butler, Pa., designed by A. J. Townsend and H. N. Naugle. This second mill, however, represented application of the principles of strip rolling to a mill 48 in. wide, and produced material in coils. The product was further processed in coil form. The Butler installation was the first in the United States to use roller bearings on hot mill roll necks.

Other steel companies quickly followed the lead of these pioneers. Successive installations of hot strip mills were made wider and the designs modified somewhat. By 1932, the general layout had become standardized much as these mills are built today. Subsequent developments have been along the line of higher speeds, increased rigidity of design, and larger drive motors.

Two developments were of major importance in the evolution of the modern continuous strip mill. The application of the four-high mill, with suitable bearings, supplied the mill rigidity so necessary for the successful rolling of wide material to the lighter gages within acceptable tolerance limits. Also, the use of adjustable voltage control on finishing train drives provided flexibility of speed adjustment, making possible the proper correlation of mill drafts in successive stands.

With the advent of continuous rolling, Association programs dealt extensively with the equipment and methods of the new process. Perhaps no other development in the steel industry was so freely discussed, and it may be no coincidence that no other development proceeded so rapidly and so successfully to its maturity. AISE has been credited with important assistance in this development.



From the old saddle-tank steam locomotive above to the modern diesel unit below is a change typical of the development in all equipment in the iron and steel plants.

IRON AND STEEL EXPOSITION

An important milestone in Association history was the start of the Iron and Steel Exposition in 1919. From the small beginning in St. Louis, with some 20 exhibitors, the Exposition has grown into a major industrial exhibit with about 200 exhibitors and attendance up to 14,000. Originally an annual event, the Exposition was suspended during World War II, and since the war it has been held biennially.

The Iron and Steel Exposition offers the advantage of visual inspection of the newest developments in steel plant equipment and supplies produced by the major manufacturers serving the industry. It offers valuable contact with manufacturers' engineers regarding technical features of their products.

RESEARCH AND STANDARDIZATION

Research programs sponsored by the Association are under way almost constantly. Major projects include work on the design of electric overhead traveling cranes (done in 1939–41 at Lehigh University at a cost of $12,000), design of ladle hooks (1946–48, Carnegie Institute of Technology, $6300), design of hot metal ladles (1946–49, Lehigh, $19,000), thermal distribution in blast furnace hearths (1953–55, Columbia, $21,000), and causes of strip mill roll breakage. This last work, still in progress, has been done at Carnegie Tech and has cost $44,000 to date. Half of this cost has been borne by the Roll Manufacturers Institute, which is a co-sponsor of the roll project.

Out of these projects have come several specifications and design standards, particularly for cranes, ladle hooks and hot metal ladles.

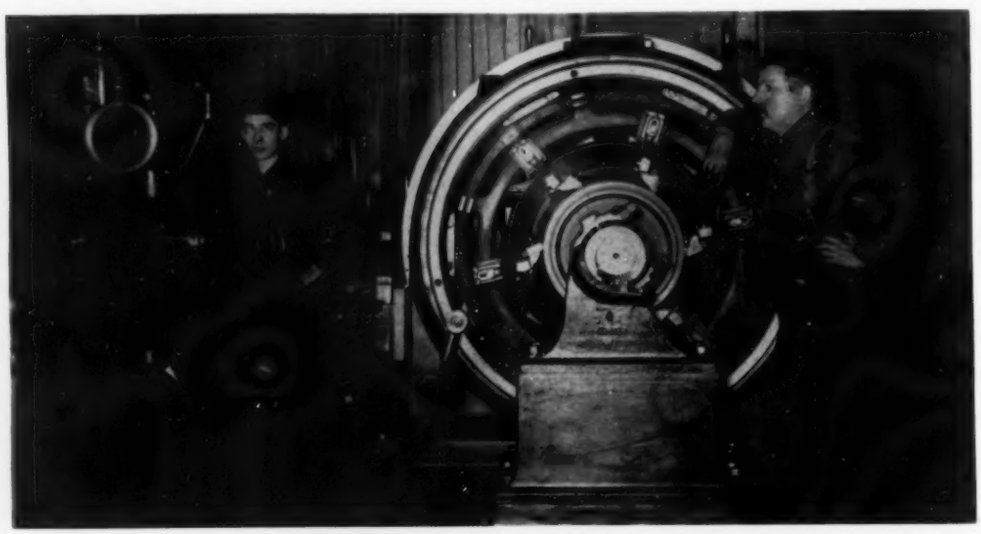
Other AISE standards have been set up as a result of committee work. The first of these, which incidentally was started at the Association's 1908 meeting, sets certain specifications for the d-c mill motors so widely used in the steel industry. Other standards cover machined surface finishes, slings and crane chains, wiring diagrams, crane wiring, carbon brushes, mill motor brakes and plain bearings.

EDUCATIONAL ACTIVITIES

Over the years, the Association has sponsored many educational projects. Some of these were series of lectures on steel plant topics, presented in the districts where there are AISE sections. The latest of these was just recently completed by the San Francisco district section in co-operation with University of California. Undergraduate scholarships and postgraduate fellowships have been supported at different times and at different schools. Last year a program of four-year engineering scholarships, named AISE Merit Scholarships was instituted. They are administered by the National Merit Scholarship Corporation, and cost $5000 each. The first of these was awarded to Ralph D. Gray, of Killbuck, O., who is studying chemical engineering at Case Institute of Technology. The second went to Robert L. Porter, of Wauchula, Fla., who is starting electrical engineering at Georgia Institute of Technology.

In honor of the founder of the Association, the AISE-Farrington Fund is maintained at Rose Polytechnic Institute. This fund ($1500 per year) is used partially for scholarship work, partially for the purchase of needed equipment. A fund is also maintained at Carnegie Library in Pittsburgh for the purchase of special reference material of interest to the iron and steel industry, costing about $700 a year.

The latest project in this field is AISE sponsorship of a comprehensive economic history of the iron and steel industry of the United States. This is being prepared under the direction of Wm. T. Hogan, S.J., of the economics department of Fordham University, and will cost $50,000. The manuscript should be completed early in 1959 and the book will be put out by a commercial publisher. It will fill a definite void in the literature of the industry.



The generator shown to the right produced power solely for electric lights in a Pittsburgh district steel plant in 1898. The two men comprised the entire electrical department, and worked only at night.

PUBLICATIONS

Information is of little value unless it is disseminated among the people who can profit from it. Accordingly, with the start of annual meetings in 1907, the Association began publication of its "Proceedings," containing the papers and discussions presented at these meetings. Older members will recall these pocket-sized, blue-covered booklets, which were published regularly until 1924, when they were changed into the monthly magazine, the *Iron and Steel Engineer*, now in its 34th year. In 1936, the format of the *Iron and Steel Engineer* was revamped, using the plastic binding which has become so much a trademark.

From the start, the *Iron and Steel Engineer* has been devoted exclusively to the design, construction, operation and maintenance of iron and steel producing plants and the equipment therein. It is editorially unique in that its content is to a great extent either contributed or suggested by the readers themselves. Technical papers presented at national and district meetings still form the principal editorial matter. These papers, originally selected by committees in the various fields of interest in the industry, are original, complete and practical, designed for the men in the steel plants.

Each year the principal articles in the magazine are permanently bound into a yearbook and made available to members. This book, a fine addition to every engineering library, provides a valuable, permanent reference for comprehensive information over a wide range of steel plant subjects—a fund of data available in no other place.

To encourage men in the industry to write articles, an award was established in 1943. Named the Kelly award in memory of John Fredrick Kelly, the first managing director of the Association, it is given annually for the best paper written by a steel plant man and published in the *Iron and Steel Engineer*. It carries certificates and cash awards of $300, $200 and $100 for first, second and third places.

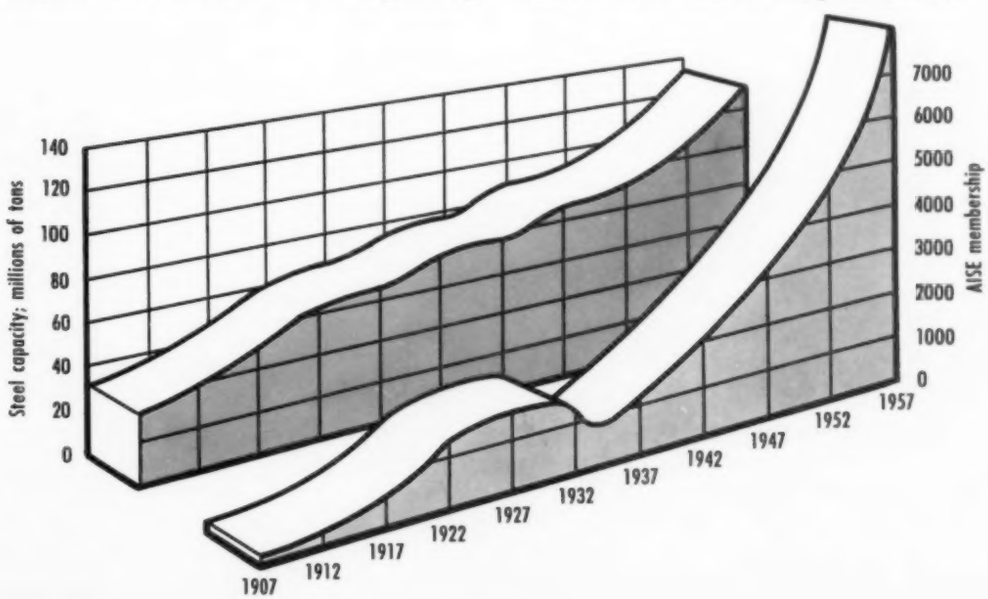
Shortly after the start of the "Proceedings," advertising appeared in its pages. Early advertisers who are still represented in the pages of the *Iron and Steel Engineer* include Alliance Machine Co., Cleveland Crane & Engineering Co., Crocker-Wheeler Co., Cutler Hammer Manufacturing Co., Electric Controller and Manufacturing Co., General Electric Co., Morgan Engineering Co., National Carbon Co., Northern Engineering Works, Pittsburgh Transformer Co., Reliance Electric & Engineering Co., Wagner Electric Manufacturing Co., and Westinghouse Electric & Manufacturing Co.

Almost 10,000 copies of the *Iron and Steel Engineer* are now circulated in the iron and steel and allied industries over the world. Outside of the United States, copies go to Africa, six countries in South America, Australia, Austria, Belgium, Canada, China, Cuba, Czechoslovakia, Denmark, Egypt, Great Britain, Finland, France, Germany, Greece, Holland, Hong Kong, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Pakistan, Philippines, Romania, Spain, Sweden, Switzerland, Thailand, Turkey, Russia, Yugoslavia, Formosa, Iraq, Korea, Portugal and Puerto Rico.

The Association has also published a number of special books in fields where published material is sparse but needed. In 1941, "The Modern Strip Mill" provided a comprehensive analysis of these new mills which revolutionized the production of sheet and tinplate products. Its 498 pages gave detailed information of the 28 wide strip mills in existence at that time. The book presented the only complete cataloging of any kind of steel plant equipment. Now out of print, it is still in demand and used copies are known to sell at $50 or more each.

Between 1943 and 1948, a series of monographs was published, including "The Modern Coke Plant," "The Modern Blast Furnace," "The Modern Open Hearth," "The Modern Arc Furnace" and "The Modern Blooming Mill." Thousands of these booklets were distributed throughout the industry and are still in use in many company training programs.

In 1953, "Tube Mill Practice" was published, made up of 23 articles on various phases of tube mills and tube production. In 1956, "Roll Design and Mill Layout," by Ross E. Beynon, was put out, forming a major addition to the little published information in this important field. At present, work is progressing on several other books in various fields of steel plant interest.



TODAY

AISE membership now includes individuals from practically all levels in the steel and allied industries, from presidents through all branches of engineering, operating and maintenance. Believing that its principal function is to help the industry it serves, the Association has kept its membership requirements less stringent than some engineering societies. It feels that any help it can give the personnel of its industry is a service to that industry. Its meetings are open to personnel of that industry, whether they are AISE members or not—and no attendance or registration fees are charged for these meetings.

Dedicated to its purpose of "advancing the technical and engineering phases of the production and processing of iron and steel," AISE schedules a broad program of activities designed to disseminate information that will help its industry and its membership throughout that industry, and to appraise and emphasize the value of new developments as demonstrated by practical experience.

The steel industry, with a capital investment of about $12,000,000,000 and an annual expenditure even greater, is big business. Spending this kind of money requires careful planning and this planning requires knowledge, ideas, experience and a broad perspective. It is here that AISE tries to help.

AISE activities include an annual convention with an exposition every other year, a spring conference under the sponsorship of the Association's rolling mill committee, and a western meeting, each with programs of plant inspection trips and technical papers covering broad areas of steel plant interests. In addition, each of the twelve district sections schedules activities on a local level.

Since AISE embraces all branches of engineering, but only within the relatively narrow confines of the steel and allied industries, it has, unlike many other engineering societies, no student membership. This is a handicap as far as membership volume is concerned, but results in a compact group of specialized interests.

Like other engineering societies, AISE will doubtless continue to grow. Equipment and controls in industry are becoming more and more complicated and, at the same time, more automatic. This means more problems for engineers and consequently more demands on their societies. Programs must be broadened to cover these needs as they come up.

AISE will continue to be of as much help as it can to its members and to the steel industry—as successfully, we hope, as it has in the past.

Rolling Mill Spindle Maintenance at Gary Steel Works

. . . . spindle maintenance problems are common to all plants in the steel industry. . . . the following paper reports experience by steel mill personnel which has helped improve spindle life. . . .

By
I. D. POTTORF
General Supervisor Maintenance Development
and
RUSSELL H. DAVIS
Maintenance Metallurgist
United States Steel Corp.
Gary, Ind.

▲ THE primary function of spindles in a rolling mill drive is to transmit torque from the driving motor or engine to the pinion stand and, in turn, from the pinion stand to the work rolls.

Over the years many variations in design have been used with varying degrees of success. Mill operating conditions and service life of spindles probably have influenced spindle design more than any other factors.

It is not the intent of the authors to discuss in this paper the design aspects of spindles as related to size, shapes, length, and strength. It is the purpose to describe the types of spindles used at Gary Steel Works, methods of manufacturing spindles, typical spindle failures and their causes, methods of repair and preventive maintenance measures.

TYPES OF SPINDLES USED AT GARY STEEL WORKS

There are two general types of spindles used on Gary Steel Works rolling mills; spindles with "wobbler" ends and spindles with "universal" ends.

The chief advantage of wobbler spindles is their simplicity with resultant ease of manufacture. Wobbler spindles are cast to size in our plant foundry and require finish machining on the bearing surface and rough machining on the ends for proper length. Occasionally the spherical surfaces on the outside diameter of the wobblers on vibrating spindles is rough machined to insure clearance with the mating coupling. The principal disadvantages of wobbler spindles are; extreme noise, backlash and poor mating on pod surfaces. Noise and backlash are inherent due to clearances maintained in casting practice. Seldom will all four pods of the wobbler mate properly with the coupling so that the torque being transmitted will be equally distributed.

The chief advantages of universal spindles are; sliding members ride on bearing metal, quieter operation, and little or no backlash. Bronze slippers provide a bearing surface movable within the spindle jaw half coupling, as well as a sliding surface for the spade end of the roll or pinion. As wear progresses the slippers can be replaced. The principal disadvantage of universal spindles as compared with wobbler spindles is the greater cost of manufacture. The universal spindle requires finish machined surfaces on the support bearing journal and on the jaw half coupling. The large amount of machining increases the manufacturing cost considerably.

Of the primary rolling mills at Gary the 40-in. and 44-in. blooming mills use universal coupled spindles. With few exceptions the remainder of the mill drives on other primary mills use wobbler end spindles.

In the finishing rolling mills, the 38-in. hot strip mill and the 9-in. bar mill use both universal and wobbler type spindles. In the 38-in. mill the four-high finishing stands have universal coupled vibrating spindles, and the rougher and edger stands have wobbler type spindles. The 9-in. mill uses universal coupled spindles only on vertical edger drives. The remaining finishing

Figure 1 — Failure of a spade half coupling on a pinion was due to fatigue.

Figure 2 — Torsional impact caused failure of wobbler type spindle. Note crystalline appearance of fracture.

mills use either a wobbler type spindle or some type of adaptation.

It is estimated that of all the mill drives in both primary and finishing mills approximately 90 per cent of the roll stands are driven by wobbler type spindles.

METHODS OF MANUFACTURE

The two methods generally used in manufacturing spindles are forging and casting. Normally the wobbler type spindles are cast, while both forging and casting are used in making the universal type.

Originally the larger universal type spindles in the primary mills were made from C-1045 steel forgings, normalized and tempered. Spindles made in this manner were expensive, not only because of the cost of the forging, but because of the extensive machining required. In addition to the economics involved, delivery dates occasionally posed a serious problem, since it was necessary because of inadequate forging facilities in the plant to purchase the spindles from outside suppliers. It was decided therefore to make a test installation at the 44-in. blooming mill using spindles cast in the plant foundry. These spindles were cast from C-1045 steel followed by a full anneal. Spindles have been made in this manner since 1948, and no failures have resulted which could be attributed to the method of manufacture.

On the universal type spindle ends, the wear is confined for the most part to the slippers, although some wear is experienced in the jaws which hold the slippers. On the wobbler type spindles, the pods are subjected to the greatest amount of wear. On this type of spindle it is customary to hard face the wobbler ends with an austenitic manganese weld rod prior to installation.

TYPICAL FAILURES AND THEIR CAUSES

Fatigue failures—Fatigue failures are caused by stress concentrations where abrupt changes in cross section occur. Changes in design have corrected localized stresses to some extent by the liberal use of large fillets. Until recent years fatigue failures were the predominant cause of spindle breakage at Gary Steel Works.

It is not uncommon for stresses in spindles to be localized to such an extent as to increase the stresses two to three times their normal values (the same is true in cases of impact or shock loads).

Figure 1 illustrates a unique failure of a spade half coupling on a pinion. This is a typical fatigue failure—recognizable by the smooth crack that has progressed from the outside surface of the spade. It should be pointed out that the casting flaw did not contribute to the failure until the fatigue crack had grown to a depth sufficient to weaken the part. Had the casting been perfectly sound, the spade would have broken eventually due to growth of the fatigue crack. This pinion is subjected to severe impact and inertia loads common to a blooming mill.

Impact failures—Currently we are experiencing more failures due to impact torsion than from fatigue. Impact and inertia loads on a mill drive can be caused by rolling cold steel, taking too large a draft or reduction on an ingot, or irregular surfaces on the ingot (such as bottom fins). Any one or a combination of these conditions offer considerable resistance to the ingot passing through the roll stand, and result in overloads on the drive.

Backlash is present in practically all mill drives equipped with wobbler type spindles, primarily because the mating pods of the spindle and coupling are cast to size, resulting in loose fits. Little or no backlash is apparent on universal coupled spindles until the slippers become worn. Worn slippers in a universal coupling accentuate impact loads as the slipper wear increases. Backlash is quite critical on reversing mill drives.

Failure of only one jaw on a spindle jaw half coupling frequently allows the other jaw to exert sufficient pressure on the spade to bend the spindle. In most cases where the spindle has been bent repair is out of the question, depending of course on the amount of misalignment present.

Figure 2 illustrates a true torsional failure. It can be seen that no fatigue cracks are present. Failures such as this are attributed to impact due to inertia loads,

Figure 3 — Failure resulted from casting defect.

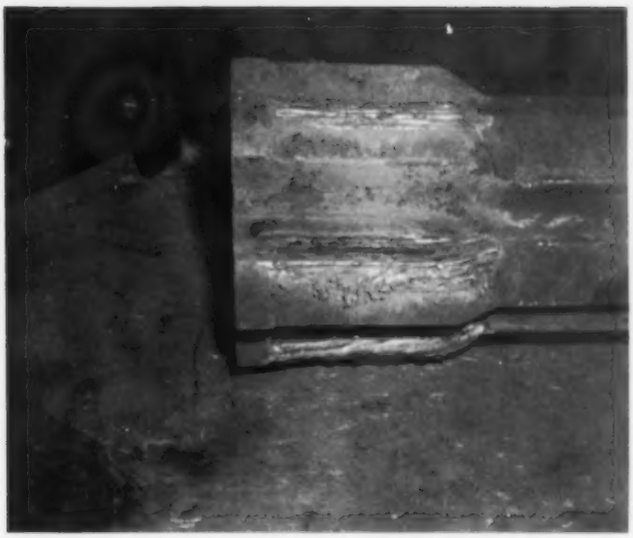


Figure 4 — Pods of broken spindle were built up and hard-faced.

backlash, or more simply an overload on the drive. The planes of failure are at an angle of 45 degrees with the axis of the spindle, which indicate a tensile failure due to torsion.

Excessive angularity or misalignment of a spindle does not cause impact loads; it does, however, aggravate the loading condition. As torque is transmitted through a drive, excessive angularity of the spindle increases the induced stresses in the ends of the spindle.

Faulty castings have not caused too much trouble as far as spindle failures are concerned. Several instances of fatigue failures have revealed segregation in the casting (see Figure 1). However, the failures were not due to the segregation, being located on or near the neutral axis of the part where stresses are relatively small. Broken spindles, used on many of the finishing mills, usually fail because of a faulty casting (see Figure 3). The majority of broken spindles are cast hollow, and should any segregation be present it will not lay on the neutral axis, but near the outer surface where it will undoubtedly contribute to the failure.

REPAIR METHODS

In general, repairs to spindles are necessitated either because of wear or breakage. Wear on the universal type spindle, as previously mentioned, is confined for the most part to the bronze slippers; however, some wear is experienced in the spindle jaws. When this occurs it is the practice at Gary Steel Works to build up the worn area with a medium carbon steel rod, followed by machining. Wear on the wobbler type spindles is confined to the pods, and as indicated previously, it is customary to hard face these wobblers as a part of the manufacturing procedure. When repair becomes necessary because of wear, the pods are stripped of the remaining hard facing material, then built up with a medium carbon steel rod and again overlaid with the manganese steel rod. Figure 4 illustrates a broken spindle on which the pods have been repaired.

When breakage occurs on the wobbler type spindles, normally no attempt is made at salvage; however, in cases of emergency, thermit welding has been employed successfully to replace broken wobblers. Thermit welding is used exclusively for repairing broken ends on the universal type spindle. Other methods have been used in salvaging these spindles, such as keying and shrinking the coupling end of the shaft, but these methods have not been as successful as thermit welding. Preparation of the broken spindle for thermit welding consists of facing off the spindle and the cast coupling on a lathe and drilling a two-in. hole in the exact center of the two pieces. A steel centering pin is then placed in the holes in order to obtain the proper alignment between the cast coupling end and the shaft. Then straps are welded around the circumference of the pieces to maintain the alignment until the thermit welding is complete. The straps are then burned off. A spindle that has been prepared for thermit welding is shown in Figure 5.

PREVENTIVE MAINTENANCE

The elimination of stress concentrations to prevent fatigue failures is limited only by operating equipment and/or conditions. The use of generous fillets, the elimination of shoulders or abrupt changes in cross sec-

Figure 5 — Spindle is being prepared for thermit welding cast coupling end to spindle shaft.

tion, and rough machining tool marks will reduce considerably stress concentrations that will eventually start a fatigue crack.

It is advantageous to provide a weak link in all mill drives. The weak link chosen should be a part that can be replaced with a minimum of downtime, and should be one that can be readily manufactured. In many cases a coupling box or a cast-to-size breaking spindle satisfies these two conditions. If some part in the drive must be broken due to overloads, etc., it is much more economical to replace a coupling box than a pinion or a spindle. Recent experiments at Gary Steel Works have saved several lead spindles on the 36-in. slab mill by reducing the wall thickness on coupling boxes. Placing a circumferential groove around the outside of the coupling box will accomplish the same purpose. As yet conclusive results have not been obtained on either method.

Dirt and abrasives in a coupling cause a considerable amount of wear. Some plants are experimenting with boots as covering for protection from dirt and scale. However, we have not attempted to cover spindle couplings at Gary Steel Works.

Lubrication remains a problem, especially on universal coupled spindles. As mentioned previously, the majority of all slippers used in universal couplings are aluminum bronze. It is known that some deformation takes place on slipper surfaces, probably caused by high torque transmission. This slipper deformation, coupled with abrasive wear and poor lubrication, has been found to be the principal causes for slipper replacement. At Gary Steel Works, lubrication of universal couplings is by pressure grease gun or by manually pouring oil into the coupling periodically. Our present lubrication practices are not totally effective; to date we have been unable to devise a better method. Lubrication of wobbler spindles is limited to coating the pods with a viscous grease during assembly of the coupling box on the spindle. After a short period of operation, the initial lubrication is of little use.

Little can be done to eliminate angularity on vibrating spindles. The initial design of the various mills gave consideration to the maximum angle that could be tolerated, and by increasing the design length of the spindle attempted to keep the spindle angle within specified limits. On lead spindles of the wobbler type, misalignment can be created if the spindle carrier bearing is not properly adjusted.

SUMMARY

In this paper the authors have described the types of spindles used at Gary Steel Works, the methods used in their manufacture, typical failures and their causes, repair methods, and finally, some of the preventive maintenance procedures that have been instituted in an attempt to increase spindle life and reduce operating delays.

The authors are aware that the problems presented in this paper are not peculiar to Gary Steel Works, nor do we feel that methods used in the repair or preventive maintenance procedures are in any way unique. If the paper will show the need for developing improved techniques relative to solving spindle maintenance problems common to all plants in the steel industry, then it will have fulfilled its purpose.

DISCUSSION

PRESENTED BY

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W. B. CARTER, General Superintendent of Maintenance, Alan Wood Steel Co., Conshohocken, Pa.

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F. DRACKLEY, Assistant Superintendent Mechanical Dept., Inland Steel Co., Indiana Harbor Works, East Chicago, Ind.

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I. D. POTTORF, General Supervisor Maintenance Development, United States Steel Corp., Gary, Ind.

F. H. PADDON, Manager, Engineering Sales, Amerigear, Salem, Ohio

T. A. BESSENT, Assistant Lubrication Engineer, Bethlehem Steel Co., Sparrows Point, Md.

GLADE C. MILLER, Rolled Product Superintendent, Fabricated Division Engineering Dept., Kaiser Aluminum and Chemical Corp., Oakland, Calif.

H. Sandberg: The foregoing paper on rolling mill spindle design and maintenance, by Messrs. Pottorf and Davis, creditably portrays the problems that are experienced in all steel plant units where heavy drives are involved.

Our practice on mills in Cleveland is comparable and typical of that described by Mr. Pottorf at Gary. The wobbler types are used on 21 and 18-in. billet mills, 12 and 10-in. bar mills, where we use alloy spindles and wobblers. Prevailing practice is to build up worn parts with hard weld. We also use thermit welding on our broken spindles.

On our 44-in. and 32-in. blooming mills, we use universal type spindles with bronze slippers. For lubricating slippers we have an annular steel oil tank (containing about 35 gallons of oil) welded to each spindle head. Oil is fed centrifugally to each wearing surface through small tube fitted with needle valve for flow adjustment. Typical consumption is about 5 gal per week for each spindle head. It has been possible to more than double the life of spindles and slippers due to wear with this method.

On our universal hot strip mill spindles, we have been repairing broken spindles with submerged arc welding which has proven satisfactory, as evidenced by no breakage at welds for some time.

The practice of providing grooves in spindles to allocate point of breakage may be advantageous in some applications, but in most cases, with reference to forged steel spindles, our practice has been rather along the lines of reinforcing where necessary to discourage breaking.

W. B. Carter: The experience at Alan Wood has been almost identical to the other two plants described. We have not substituted castings for forgings yet. We do

groove our coupling boxes, and in general they break in the groove.

We had almost identical experience in substituting oil reservoirs on the end of the spindle, we doubled our tonnage over previous grease lubrication which had a complicated canvas boot over the ends.

Our hot strip mill is equipped almost entirely with the wobbler type. We are constantly behind because we never build them up fast enough. They seem to wear in spite of the hard surfacing materials we use.

We have a new four-stand tandem cold mill which is 15 months old, using universal type couplings. We started out consuming five sets of spindle slippers a month, which was exceedingly high to us, and we kept trying types of lubricants until now we have found one that only requires about one set of slippers a month.

Harvey Demmon: This paper will serve its purpose if it brings to light the apparent lag in the development of more suitable and less costly drives between pinion stands and the mills of the present day rolling mills.

As brought out in the paper, the old wobbler type spindles, while many of them are in use, are obsolete and are not used in the higher speed more up-to-date mills. The spindles having the so-called universal slipper type coupling, while a big improvement over the wobbler type, are expensive and are inherently hard to lubricate. A good lubricating system for this type of spindle is not in general use.

Attempts to incorporate breaking points that will cause spindles to break at predetermined points have been only partially successful. It is believed undesirable to have the breaking point of any spindle in the coupling boxes or the universal ends of slipper type spindles. However, many of them do break at this point regardless of how a predetermined breaking point has been planned. The authors have shown how a cast steel end of a spindle is repaired by thermit welding. In our plant we have eliminated all thermit welding of spindles, and repair them by inserting a large pin in the center of the two sections to hold them in line and then rotate and arc weld in a shielded-arc welding machine. The depth of the weld determines the strength of the spindle, and we endeavor to have this the breaking point. If the spindle breaks in the weld, the spindle will be held in line and no further damage will take place. About 50 per cent of our spindles break at the predetermined breaking point.

The direct cost of maintaining the spindles and couplings between the pinion stands and the rolls in our 80-in. hot strip mill amounts to about 6 per cent of our total maintenance cost. This, however, is not the total cost because the breaking of a spindle often causes other damages, such as broken rolls or damage to the pinion stands. Moreover, the production loss from mill delay in the event of a spindle failure is very costly. In our opinion, we are in need of a better lubricating system and a more positive breaking point to improve costs on slipper type spindles.

At the present time we have a few of the universal joint type couplings on temper mills and are hopeful that these can be made to take the place of the slipper type couplings on mills where the angle of the spindle is as great as in a hot strip mill.

F. Drackley: The authors experience is somewhat similar to that which we have had at Inland.

There are several questions that I would like to offer. The first one is: "Has Gary ever substituted submerged arc for thermit welding in reclaiming universal spindle halves? If so, what is the comparison on cost and time of repair?"

The second question is: "What practice is used for stress relieving after hand welding of wobbler type spindles and couplings? How many times do they recondition spindles and coupling boxes in this manner?"

The third, and last question is: "What is the maximum wear allowed in a blooming mill of universal type spindles before reconditioning?"

Russell H. Davis: In reply to Mr. Drackley's first question, we have never used the submerged arc welding process, mainly because it is only recently that we have had the equipment to handle parts of this size. It is therefore impossible to compare the cost of the two processes.

With regard to the second question, we have determined through experience that it is neither necessary to preheat coupling boxes and spindles prior to hand welding, nor to stress relieve them after welding.

I. D. Pottorf: The maximum wear allowed on slippers in our universal coupled spindles in the 44-in. blooming mill is approximately ¼ in. There have been occasions when total clearance in the coupling has been ½ in., however, this is an exception rather than a rule. Most frequently the replacement of worn slippers is dictated by the availability of the mill. The first indication of excessive clearance is the "slapping noise" in the coupling during reversal of the drive.

F. H. Paddon: The paper and previous discussions outline application requirements that have not been met by existing spindles as to shape, areas, material and lubricants necessary to transmit desired torque at spindle angle of operation.

Spindle operating angle should be given serious consideration, as all spindles, pod, slipper, or gear type, have capacities that decrease as angles increase.

Concerning spindle costs, true evaluation should be made of not only initial cost, but over-all operating and maintenance cost. What is the cost per ton to maintain your spindles?

This point is raised as the end cost for gear type spindle utilization is well justified.

In the last few years a large number of gear type spindles have displaced various previous spindles, and have proven their ability. Application to hot mills is just being undertaken, and with proper selection indicate good performance.

The necessity for breaking points in spindles still exists, for if spindle shafts do not twist or break, a more critical gear or other item will. It is good insurance to have a predetermined weak point.

Member: I would like to ask about the lubrication on the cold reduction mill if the author has one, or is he using a rolling solution? Is he having lubrication difficulties?

At Kaiser we were using grease, and finally we went to just trying our rolling solution on the spindles with which we have had good success. Our experience on spindle life is as good as we had with regular lubrication even though we are using a rolling solution directly on the slippers which are out a half inch in length. I started off on the number one stand and worked

through number five and up to the high-speed mill, and we have had good success for the past year.

On our rolling mill, our lubrication engineer developed a new grease which increased spindle life. A few years ago we were using a drip system the same as at Inland Steel, and about six months ago this new grease was tried which will hold for approximately 48 hours of continuous operation. To be on the safe side, we are greasing our slippers every 24 hours while we still have an ample film of lubricant on our slippers.

We have increased our spindle life about three to four times. That was our worst mill on slippers, and then we moved to the plate mill and our 86-in. hot strip mill, all of which have universal type couplings.

I. D. Pottorf: Gary Steel Works does not have a cold reduction mill; for this reason I cannot answer your question.

T. A. Bessent: We do not have any abnormal difficulties with our cold mill spindles. There are two types of spindles used on our mills. The tin mills utilize the conventional spindles with bronze slipper brasses. These are lubricated during roll changes with a tacky extreme-pressure lead-base lubricant having a viscosity of 1000 SSU @ 210 F. The brasses are subject to considerable wear and short life when worn rolls are used and the drive angle is greatest.

In the sheet mills an enclosed type spindle is used. Slipper brasses are utilized in the spindle as well, with the spindle being enclosed for retention of the lubricant. This results in much more positive lubrication than is possible on the open type. An extreme-pressure grease of 350 worked penetration is used on the four-stand tandem mill and on the last two stands of the five-stand tandem mill. The spindles on the first three stands of this mill are lubricated with the same tacky extreme-pressure lead-base, 1000 SSU @ 100 F lubricant that we use on the open spindles. We get good spindle life on the four-stand tandem mill and on all but the last stand of the five-stand tandem mill.

We would be interested in more information on the method of lubricating the cold mill spindles with the rolling solution as described by the man from Kaiser. He also mentioned a grease which lasts for 48 hours and gives longer life on blooming mill spindles. Our present method consists of a greasing period every eight hours in addition to pouring oil on the brasses. I concur with Mr. Demmon's comments that the mill builders should furnish a better coupling equipped with a better lubrication system.

I have one question. On the blooming mill spindles repaired by thermit welding, have you experienced any breakage in the weld?

Russell H. Davis: We have never had a failure, either in the thermit weld or adjacent to it. We have taken tensile specimens from thermit welded areas and have found that the mechanical properties obtained on these tests closely resemble those taken from forgings.

Glade C. Miller: Have you ever had any experience in cast-to-size slippers? If so, has your experience been good or bad?

Have you had any experience in replacing the couplings, by keying them to the spindle rather than thermit welding. What was your experience on the results?

As preventive maintenance, have you done any nondestructive testing of either your couplings, the spindles, or the pods?

Has anything been done in regard to the welding of the coupling itself on the inside where your slippers fit? If so, what material do you weld it with?

The geared type coupling has been mentioned a number of times and we have had some experience with it. One of our major problems today is lubrication. I think that lubrication has also been mentioned as a problem in the use of universals, but the use of gear type couplings has increased these problems. What method has been used in your plant to obtain satisfactory lubrication for this equipment?

Russell H. Davis: Yes, we have had experience with cast-to-size slippers. We use aluminum bronze (ASTM B-148-52, Grade 9D), and have had excellent results with it.

The only method we have used in replacing coupling ends on spindles is by the thermit welding process, although I understand that other plants have used the keying method successfully.

We build up the jaw half coupling by using a medium carbon rod.

I might mention in connection with the dye penetrant method of testing that on occasions, when we have broken one end of a spindle, we have detected cracks in the opposite end by this method, and have replaced the cracked end before a delay-causing failure occurred.

I. D. Pottorf: We use two methods of non-destructive testing at Gary Steel Works; the ultrasonic and dye penetrant. Non-destructive testing as a preventive maintenance measure has been used very little on spindles and couplings for the following reasons:

1. Test results with ultrasonic equipment are dependent on grain size, porosity and test surface. Spindles and couplings at Gary are cast steel, and due to large grain size, porosity, and a cast surface, results are poor even when using low frequency crystals such as 0.5 to 1.0 megacycles.

2. Few spindle and coupling failures can be classified as progressive failures (fatigue), and should we be able to use the ultrasonic method more effectively, a crack in a spindle would be detected only if it was a progressive or fatigue crack.

We do not have any gear type couplings on any of our mill drives at Gary Steel Works. For this reason I cannot answer your question. Gear type couplings are being considered to replace universal couplings on the finished stands in our 38-in. hot strip mill.

Are you annoyed by having someone borrow your magazine when you want it? Get him to join the AISE.

establishing and applying MAINTENANCE INCENTIVES

By R. B. HEWETT

Company Industrial Engineer, Crucible Steel Company of America, Pittsburgh, Pa.

▲ DURING the last year or two, many articles have been written and many papers presented on the subject of incentives for maintenance workers. Most steel men undoubtedly are familiar with the claims for savings and other benefits attributable to one particular maintenance incentive plan or another. This article will make no such claims. Instead, it will work out the steps necessary to establish an incentive for maintenance workers. It will cover the preliminary considerations, a recommended and alternate procedure, and will work out a typical case study.

The type of plan to be discussed, while not ideal, does have advantages; among which are: (1) it is basically sound; (2) it is not too costly to install; and (3) it provides benefits to the company as well as to the employee.

The plan follows the same principles and procedures used by many other companies.

When one speaks of incentives, for an individual worker or group of workers, one refers to a method of pay—over and above a fair base rate—to compensate for extra effort which results in increased output of a given unit, department or plant. The incentive must be expressed in terms that are understandable to the employee, easily identified with the effort expanded, and applicable to accounting practices including recording and controls.

A sound incentive measures the contribution of the employee and compensates for the maximum utilization of equipment, materials and manpower. It will benefit both the employee and the company.

A good incentive will:

1. *Produce lowest cost per unit*
   a. Full utilization of equipment.
   b. Maximum production.
   c. Minimum delays.
   d. Improve quality.

....it is very difficult to set up incentives for maintenance and service personnel....the system described here is successfully used by the Crucible Steel Company of America....

2. *Create satisfied employees*
   a. High earnings commensurate with increased production and effort.
   b. Prevent inequities in pay structure.
   c. Create competitive interest.
3. *Allow improved over-all supervision*
   a. Foremen can plan improvements.
   b. Foremen can improve scheduling.
   c. Foremen can collaborate with other departments.
4. *Produce basis for accurate costs*
   a. Incentive standards easily converted to cost standards.

This criteria of a good incentive was developed to apply to direct production workers, but let us explore it and see how it pertains to indirect workers such as maintenance people.

A good maintenance incentive should accomplish each of these objectives except the direct attainment of maximum production. This is only because maintenance men do not work directly on production work and can only contribute indirectly to actual production.

If an incentive for maintenance workers will accomplish the same benefits as those for production workers, why has industry, in general, and steel com-

ASSIGNED MAINTENANCE AREA_____

STUDY NO. _____ DATE _____ TURN _____

Observation Time	Millwright	Millwright	Millwright Helper	Lubricator	Motor Inspector	Motor Inspector	Motor Inspector Helper

Figure 1 — Observations are recorded on form shown.

panies, in particular, been so slow in establishing them? The reasons can be summed up as follows:

1. It is usually more difficult to measure the work performed by most maintenance workers.
2. It is often necessary to have a minimum or more nearly fixed crew on hand which cannot fluctuate with the actual work available.
3. Cost of establishing, administering and keeping plans up to date offsets many of the benefits to the company.

Thus, most companies which have a limited number of industrial engineering hours available have expended these hours in the areas of greatest return which are usually on direct production work.

However, as incentive coverage and earnings on direct workers increase, the problem of equity between the earnings of direct and skilled indirect workers arises. When a skilled maintenance man works close to a production worker and makes considerably less money for what he considers more work, he believes the company is discriminating against him. The morale and productivity of these indirect workers may diminish as a result. Also, partly as a result of modernization, maintenance is becoming an increasing part of the over-all labor cost, thus making the target larger for potential savings due to better measurement.

Therefore, developing incentives for maintenance and other indirect workers becomes more urgent.

Since Crucible has followed a similar policy of establishing incentives in those departments and on those jobs where the most benefits can be derived, Crucible concentrated first on production units, then on service units and then, as a result of reasons mentioned above, recognized the necessity and desirability of proceeding into maintenance areas.

The problem is one of establishing a plan for the maintenance worker which will be based on his individual work contribution, which will not be too expensive to develop and administer, and which will be fair both to the employee and the company.

Now, how can one measure maintenance work? Measurement of the maintenance worker's effectiveness can be made in several ways such as:

1. *Analysis of historical records*

A prerequisite to this type of measurement is, of course, good records of maintenance work performed. Having this, even the best statistical analysis can only reflect an average condition without regard to actual performance of work difficulties encountered during the period being studied.

2. *Estimating*

This is a widely used method but not true work measurement. The time required for each job is estimated by either a foreman or by a separate estimating section. This estimate is only as good as the ability of the estimator to forecast conditions and to thoroughly understand the details of the jobs to be performed. Poor estimates can quickly lead to worker resistance, and estimates on brand new jobs have little or nothing to use as a guide.

3. *Standard data*

Either one's own or a consultant's—based on time study of elements or basic components and put together for each job. Standards constructed by this means are usually excellent but are very costly to construct and cumbersome to administer.

4. *Actual time study*

Developing standards by studying each and every job. This process can take an extremely long period of time and thus can be even more costly than utilizing standard data purchased from outside consultants.

5. *Work sampling*

Studying work performed, and breaking elapsed time into several categories such as idle time, work time, and enforced delay time. This method is based on the statistical theory that sufficient spot observations or samples will accurately indicate a picture of the entire operation.

Each of the above methods, or combination of them, has advantages and also disadvantages. Perhaps the method which would work the best in one shop on one kind of work would not work as well in others. Experience has shown that work performance can be satisfactorily studied in the maintenance areas by the work sampling method checked by a few well-selected time studies.

Work sampling is a comparatively new technique which has proven to be accurate when performed in a thoroughly planned manner in which sufficient randomness occurs and enough studies are made. Studies can produce results in a matter of weeks which would take many months by conventional time study methods.

Our first application of work sampling was about two years ago in a large warehouse where conventional time studies failed to provide answers to our problems. We restudied the department by use of work sampling with very satisfactory results. We have been using it in many areas since and are convinced of its value and accuracy.

Now we will take a sample case and will develop an incentive for the assigned maintenance workers. The sample has been greatly simplified but is intended to bring out the important points.

There are seven maintenance men per turn in this example: two millwrights, one millwright helper,

one lubricator, two motor inspectors and one motor inspector helper. This same crew works on each turn seven days—21 turns per week, at an average rate of $2.38 per hr.

These maintenance men service three medium sized producing units on which 40 direct workers per turn are working 3 turns per day, 7 days or 20 turns per week.

The units are an incentive and each is producing at *expected levels of production.*

TABLE I
Maintenance Crew

2 Millwrights	Job Class 14	$2.576 per hour
1 Millwright helper	Job Class 6	$2.072 per hour
1 Lubricator	Job Class 8	$2.198 per hour
2 Motor inspectors	Job Class 14	$2.576 per hour
1 Motor inspector helper	Job Class 6	$2.072 per hour
7	Average base rate =	$2.38 per hour

Servicing Operating Units

Unit No. 1	25 Men per turn
Unit No. 2	10 Men per turn
Unit No. 3	5 Men per turn
	40 Men per turn

The number of observations necessary were determined to be 2970, by using the statistical formula:

$$N = \frac{4(1 - p)}{y^2 p}$$

in which N = number of observations
p = anticipated downtime (35 per cent)
y = Accuracy required (±5 per cent)

$$N = \frac{4\ (1 - 0.35)}{0.05^2 \times 0.35}$$

$$= 2970$$

It was decided to make these observations around the clock on a three-turn basis, checking each occupation on an average of four times per hour at random periods. This required one time study man per turn for one week.

The following elements were to be determined by the observations:

Work elements

a. Inspect
b. Repair
c. Assemble
d. Lubricate
e. Walk (to and from jobs)
f. Receive and give instructions
g. Miscellaneous (clean up, replace tools, etc.)

Idle

h. Personal
i. Required idle (crane or operating delay)
j. Idle

Each of the units worked on were to be noted according to Unit No. 1, No. 2 or No. 3 with minor units of equipment identified as equipment No. 4, No. 5, etc.

Operations were recorded on a form similar to that in Figure 1.

The start and finish time of each tour was recorded in the left hand column and the work or idle element and location was recorded for each occupation.

Bear in mind that the tours were made at random times determined beforehand and each tour was made using different routes.

The item recorded was based on the activity observed at the moment of first sight of the worker.

We must point out that prior to such a study, much work must be performed with maintenance supervision to ensure that the crews and methods being followed represent good maintenance practice and also represent normal conditions.

A study such as this would be impossible without very close cooperation between the Industrial Engineer and maintenance supervision.

Table II is a summary of the study.

TABLE II
Summary of Study

Element	No. of occurrences: First turn	Second turn	Third turn	Total	Per cent
Work					
a. Inspect	165	110	140	415	12.4
b. Repair	230	430	360	1020	30.5
c. Assemble	35	30	19	84	2.5
d. Lubricate	17	15	15	47	1.4
e. Walk	100	65	85	250	7.5
f. Instructions	13	29	18	60	1.8
g. Miscellaneous	60	55	45	160	4.8
Total	620	734	682	2036	60.9
Idle					
h Personal	66	65	69	200	6.0
i. Idle required	46	48	56	150	4.5
j. Idle	383	268	313	964	28.6
Total	1115	1115	1120	3350	100.0

Average Standard Hours Produced per Turn

Standard hours Produced by production units Average per turn	No. 1	..	..	..	10.8	135
	No. 2	..	..	..	10.4	130
	No. 3	..	..	..	9.2	115
	Total	..	..	..	30.4	...

The first step upon completion would be to verify statistically the accuracy of the study. This is done by reverse use of the same statistical formula used to determine the number of observations required.

Notice that the maintenance group was performing work elements 60.9 per cent of the time and was idle 39.1 per cent of the time. A vital part of any accurate work measurement study includes pace rating and allocation of proper personal and fatigue allowances.

There is considerable question as to the possibility of accurately rating pace on a series of instantaneous observations. We, therefore, determined the pace on the basis of an over-all average for all of the mechanical people being studied.

For the purpose of this illustration, pace was rated at an average of 87 per cent and a rest and personal allowance of 15 per cent was made.

This levelling brings the work load for the group to 60.9 per cent which means that, for every hour actually spent on the job, 0.609 hr of work is performed.

During each 8-hr turn, the producing units produced an average of 30.4 standard hr.

The study has now been completed and checked by several time studies. The next step is to develop the standard. There are some differences in thinking and practice on this step, but we believe our method to be sound.

In a given week, the maintenance crew is on the

job 1176 actual man hr—7 men x 7 days x 24 hours per day—produces 716 standard hours of work (60.9 per cent x 1156).

During the same week, 608 standard hours are earned by the producing units.

Table III, the standard for the maintenance crew, shows 716 divided by 608 or 1.18 standard maintenance man-hr per standard hr earned by the three producing units.

TABLE III
Development of Maintenance Standard
(For Period Of 1 Week)

Actual man-hr worked (7 men × 7 days × 24 hours per day)	1156
Standard man-hr work performed (60.9 per cent × 1156)	716
Standard hr earned by producing units (20 turns × 30.4 per turn)	608
Maintenance standard (man-hr per standard earned hr of producing unit) (716 ÷ 608)	1.18

One may question the propriety of measuring the work performed by the maintenance crew in terms of production of the direct units. Our answer would be that this basis is reasonably correct for the following reasons:

1. Week in and week out, the level of operations controls the amount of maintenance work required.
2. The hours earned by the producing units reflect the true level of production, and is a figure already on hand for ease of determination.
3. Any other more direct means of measuring the work would be too complicated and costly to develop and maintain.

We now have a standard. How will we pay off on this standard? One may believe that a 60.9 per cent work load is too low to warrant any incentive payment. Let us examine the reasons behind this work load. Generally, it would indicate that the unit is either overmanned or the nature of the services required are such that the skills of several occupations are needed regardless of individual work requirements. The studies indicated that both factors contributed. Studies also revealed that, in our best opinion, all required maintenance could be performed satisfactorily with the crew reduced at least 1 man per turn. This reduction would still provide a possible work load of only 71 per cent.

The question still arises: Why should we pay incentive for such a low work load? The answer lies in one of our basic policies of incentive development. On many operations, as a result of restrictions beyond the control of the employee, he is forced to be idle after completing his work at incentive pace. In such cases, the employee should be compensated at the standard hourly wage rate for that *required* idle time—or, as we call it, process allowance.

On the basis of crediting process allowance, some incentive would be realized at 60.9 per cent work performance and a greater amount at the average attainable work performance of 71 per cent.

On this basis, we have established a method of payment exactly as we would on a direct operating or service unit where there is a great variation in the amount of required idle time and the number of performance standards would be so large as to be impractical of measurement.

The performance is calculated by dividing the earned maintenance man-hr by the actual maintenance man-hr worked during the pay period. The pay would be derived from a preprinted table which has an appropriate process allowance worked into it for each index of performance. The percentage paid is based on the standard hourly wage rate of each member of the crew for each hr. worked by him during the pay period. By basing this incentive on a pay period, we have a more stabilized set of conditions and thus more stabilized earnings without wide variations. This also permits supervision to better schedule repairs.

This, in essence, is our developed incentive plan. Let us apply the plan to a few representative weeks.

Table IV illustrates:

1. The incentive applied first to a week during which present conditions prevail.
2. The incentive applied to a week during which the same production is maintained, but the maintenance crew has worked with six men per turn instead of the original seven.
3. The incentive applied to a week during which production has increased 8 per cent and maintenance crew works with one less man on 1-turn only each day. We will assume that the 8 per cent increase in production was brought about by better preventive maintenance and fewer delays.

TABLE IV
Application of Maintenance Performance Standards

	Week		
	First	Second	Third
A. Maintenance hr worked	1176	1008	1120
B. Earned production hr	608	608	656
C. Earned maintenance hr (1.18 × Item B)	716	716	774
D. Work performance, per cent (Item C ÷ A)	61	71	69
E. Pay performance, per cent (From table)	112	121	120

Weeks two and three in Table IV illustrate how earnings of the assigned maintenance workers can increase through better and more effective work reflected by fewer man-hr, higher production or both.

The costs of present application and the cost for each of the other two applications are given in Table V.

TABLE V
Comparison of Maintenance Costs

Present	Per week	Per hr standard produced
1176 Man-hr at $2.38 per hr =	$2794	$4.58
Upon installation		
1176 Man-hr at $2.38 x 112 per cent =	$3125	$5.14
(increase)	$ 331	$ .56
IF		
(a) Maintenance man-hr reduced by one millwright per turn (168 hr)		
1008 Man-hr at $2.35 x 121 per cent =	$2860	$4.70
(increase)	$ 66	$0.12
(b) Maintenance man-hr reduced by one millwright on one-turn only (56 hr) and production increased by 8 per cent		
1120 Man-hr at $2.37 x 120 per cent =	$3180	$4.84
(increase)	$ 386	$0.26

Direct savings do not exist. However, although direct costs are increased in week number 3, the indirect savings would result in over-all cost reduction.

This, in essence, illustrates the principles and the methods used.

By C. MELVIN SMITH, Plant Engineer, Rotary Electric Steel Corp., Detroit, Mich.

MAINTENANCE PLANNING AND ENGINEERING

▲ IN a small plant, an engineer is brought close to maintenance, and because he is with the millwrights and electricians on breakdowns every so often, he becomes especially aware of their problems.

A millwright in a small plant, spends many hours maintaining the equipment. While we do not like them to use premium hours for this work, sometimes it is necessary because of repairs that cannot be done during operations.

Most of the equipment has carbon shafts and gears. If a shaft is broken or gears wear out, one tries to determine the cause. If the conclusion is that shaft or gears are broken because of rough operation, they are replaced with shafts or gears made of alloy steel. For example: the billy rolls on either side of the 36-in. mill housing used to break about every three months. After they were replaced with alloy rolls, they lasted two years.

One of the two pods on the 36-in. mill pinion was broken where it fits into the spindle. Upon inspection, it was found that the diameter of the pod and spindle at this connection could be increased thus increasing the pod surface by 20 per cent. This completely eliminated the weakness.

One of the component parts of the open-throated 36-in. mill shear is an ell-shaped casting with the bottom of the ell acting as the shear anvil, and bottom knife holder. Due to heat pick-up in the anvil while shearing, expansion and contraction stresses would set up in the vortex of the ell, and with time, the casting would crack in two. A new casting was made, with the leg of the ell 18 in. below the shear line. A separate casting was then bolted on top of this leg to hold the shear knife. It has been five years since this casting was broken.

Tough stainless grades are handled by burning with acetylene, oxygen and powder. Such materials are not sheared.

One of the maintenance problems was stopping leaks in the oil and steam lines going to the soaking pits, which were at that time oil-fired. The cost of oil kept rising to where the comparative cost per Btu of gas made it more wise to change to gas. The master mechanic was pleased when this maintenance problem was past history.

The plant used to have concrete brick-lined 36-in. mill cooling pits. The brick lasted about six months. Then the lining was changed to one of lumnite cement mixed with blast furnace slag-aggregate. This lasted two years. Since then an extra lining of 2-in. steel slabs has been added, held in place with 4 x 4 in. steel billets on 4-ft centers. It is now only necessary to patch the concrete and lining every four years.

The covers of the 36-in. mill cooling pits were made of welded structural steel. Constant heating and cooling caused the welds to break, giving a maintenance problem. Since changing to a well-riveted cover, maintenance is practically nil.

Continual maintenance was required on a structural platform running between the ingot-stripping tracks.

. . . . if the engineer can find it possible to spend time in the plant, he may obtain ideas which will enable him to redesign equipment to minimize maintenance . . . .

The platform was redesigned using 8 x 8-in. steel billet posts, embedded in 4 ft of concrete, using 2 x 8-in. steel stringers and cross-ties inserted in slots at the top of the posts. Two-in. steel slabs resting on the stringers were used for the platform. The only welding used was on the slab-keeper plates. The platform is still in good condition after four years.

The floor-operated ingot stripper used to be encased in structural steel. It was not considered safe to observe the operation of the hydraulics while the stripper was operating, so the platform was redesigned. The new platform consists of steel billet posts and 2-in. steel slabs. Now the hydraulic pumps can be checked while operating without fear of a 15,000-lb mold or ingot crashing through.

On the No. 1 bar mill, there is a recirculating water system that is used for mill stand lubrication, roll pass cooling, scale flushing, and furnace skid pipe cooling. The undesirable features are as follows:

1. If the pumps stop, the furnace skids will burn up, causing a 2-day production loss.
2. The system has to run after mill shutdown, and on furnace light-up, to prevent skid trouble.
3. The system has to run on downturns in the winter to prevent freeze-ups.

There was a chance to eliminate these undesirable features when the recirculating water system was built for the new No. 2 bar mill. It was done in the following manner:

1. Although the furnaces were batch-type, the doors were not water-cooled. This eliminated the need of pumps running on the light-up turn. It also eliminated the danger of furnace doors being ruined if the pump stopped.
2. All water supply lines to the mills are sloped, so that by opening one valve in the pump house when the mill is shut down, the whole system drains through the hot well to the sewer. There thus can be no freezeups and no maintenance man is required on downturns.

In the No. 2 bar mill, gratings were installed directly above motors that were in pits.

Stairways were built and recess wall lighting was installed in pits where lubrication, hydraulics and coiler equipment are located.

Stairways and lights were also installed beneath the hot beds.

Because of the knowledge the plant engineer picks up while going through the mills, and talking to the men, he has been able to redesign or improve equipment, thereby decreasing possible downtime and maintenance costs.

SPRAYWELDING

. . . . spraywelding process saves application time compared with ordinary hand or machine welding and also requires less finish time . . . . less material is also used . . . .

▲ THE hard facing of maintenance parts, subjected to abrasive and corrosive wear, has been generally accepted as a very useful preventive maintenance tool in steel mill operation. The question today is not whether to hard face parts subjected to wear and consequent repetitive replacement, but rather which of the many hardfacing processes should be employed. The answer to this problem is usually evolved from the consideration of the following five factors:

1. Analysis of the material to be hard faced.
2. Type of wear involved.
3. Frequency of replacement.
4. Maximum allowable wear.
5. Cost of the application.

Spraywelding has been selected from the field of hardfacing processes as the subject for this article because of the increasingly important position it has assumed in our maintenance program.

THE PROCESS

The spraywelding process involves three basic operations which are as follows:

1. Preparation of the surface to be treated.

The piece must be free from all surface treatments such as plating, carburizing, nitriding, etc., and be degreased if necessary. If the surface hardness is over 30 Rockwell C the part should be annealed before proceeding. In most cases it is necessary to undercut the surface to provide for the desired thickness of the overlay. The depth of the undercut should be determined by the amount of wear permitted in service. In general, the undercut rule followed for our maintenance work calls for 0.015 in. per side for resistance to corrosion, and varies from 0.025 in. per side to 0.040 in. per side for resistance to abrasive wear. In any case, the maximum depth of undercut should never exceed 0.060 in. per side. On round, flat or curved sections, where the undercut area to be sprayed extends to the ends of the piece, a $\frac{1}{32}$-in. radius should be machined on the edges of the section. On round sections, where the area to be treated does not extend to the ends of the piece, a gradual taper of not more than 30 degrees with the longitudinal axis of the piece must be machined at the ends of the undercut area. These precautions are necessary to prevent lifting of the overlay during the fusing operation.

After the surface has been undercut it should be grit blasted if possible. If blasting facilities are not available round surfaces may be prepared by rough threading. Proper preparation of the surface cannot be overstressed since a sound mechanical bond between the base metal and the overlay is imperative during the fusing operation.

2. Spraying the surface.

The spraywelding equipment consists of a gun, a carburetor and a hopper, a pressure-reducing valve and an air filter. The powder is fed from the hopper through the carburetor or venturi where it is picked up by an air jet which propels it through a hose to the gun. The powder passes through the gun where it is heated by an oxyacetylene flame to its plastic range and then is blown onto the prepared surface.

Whenever possible the gun should be held in a mechanical device and moved at a constant rate of speed so that the resultant overlay is uniform in thickness. For shaft work, pins and sleeves the parts to be sprayed are held in the chuck of a lathe and the gun in a holder clamped to the carriage of the lathe as shown in Figure 1. The tip of the gun should be about 5 to 6 in. from the work and the surface speed of the piece should be such that approximately 0.007 in. of powder is deposited per pass. Light fast passes will result in better heat equalization. The thickness of the overlay before fusing may be calculated for each piece; however, it has been found that in general for an undercut of 0.020 in. to 0.040 in., the diameter of the sprayed piece before fusing should be 0.040 in. greater than the finished diameter.

3. Fusing the overlay.

Regardless of the method employed, the principle involved is to bring the overlay and the base metal to the fusion temperature of the alloy being worked. At this temperature the overlay will wet and bond to the base metal.

At Steelton, the controlled atmosphere furnace method is preferred because of the excellent results and speed with which the operation may be accomplished. Using this method, a number of parts are placed in a low-heat electric furnace, with a reducing atmosphere, and brought from 1600 to 1850 F at a relatively slow rate of speed of 8 degrees per minute. The temperature of 1850 F is just below the plastic range of the No. 6 alloy and, therefore, may be held indefinitely. After the pieces have soaked out at 1850 F, they are transferred, a few at a time, to a high-heat electric furnace and brought up to the fusion temperature of 1900 F in a few minutes, depending on the size of the section. As soon as the 1900 F temperature is reached, the pieces are removed from the furnace and either air-cooled or slow-cooled in an annealing furnace, depending on the analysis of the base metal. The fusion temperatures for the No. 4 and No. 5 alloys are 2025 and 1950 F, respectively.

Another common method of fusing is with an oxyacetylene torch. For small parts this method is entirely

A Hard Facing Preventive Maintenance Process

By J. R. SMITH

Development Engineer, General Mechanical Dept., Bethlehem Steel Co., Steelton, Pa.

satisfactory; however, for large sections it is sometimes difficult to get enough heat into the piece.

Induction heating may also be used if equipment is available and a number of the same size parts are to be treated.

FINISHING THE OVERLAY

The finishing method employed depends on the degree of finish required. Of course, the finer the finish, the less the operational friction and, therefore, the longer the life.

Deposits of No. 4, No. 5 and No. 6 alloys may be machined with carbide-tipped tools, such as 883 carboloy or equal. For roughing, the tool should be ground with a slight lead and rake angle and a slight radius of about $\frac{1}{32}$ in. A fine feed of about 0.003 in. per revolution should be used, with approximately a 15 sfpm spindle speed. The tool should be set $\frac{1}{32}$ in. below center. For finishing, the tool should be ground with a slight lead and rake angle and a larger radius than for roughing, or about $\frac{1}{16}$ in. A fine feed, maximum 0.005 in. depth, at approximately 45 sfpm, is recommended. These procedures will produce a satisfactory finish, but tool marks will still be present.

All of the spraywelded work at Steelton is finished by grinding with a green silicon carbide grinding wheel of "J" hardness. A 36-grit wheel is used for roughing and a 60-grit wheel for finishing.

TABLE I

Properties of the Sprayweld Overlay

	No. 4 powder	No. 5 powder	No. 6 powder
Chemical analysis in per cent			
Ni	75–85	71–81	65–75
Cr	8–14	10–17	13–20
B	2–3	2–4	2.75–4.75
Fe, Si, C	8 Max	9 Max	10 Max
Hardness, Rockwell C	35–40	45–50	56–61
Specific gravity	8.22	8.14	7.80
Melting point, F	2025	1950	1900
Abrasion resistance	Good	Very good	Excellent
Corrosion resistance	Excellent	Excellent	Excellent
Impact resistance	Very good	Very good	Good
Galling resistance	Very good	Very good	Excellent
Red hardness	Excellent	Excellent	Excellent
Average coefficient of expansion from 122 to 1202 F in in. per in. per degree F	856×10^{-8}	841×10^{-8}	814×10^{-8}

ENGINEERING DATA

The ability of a hardfacing material to retain its hardness under elevated temperatures is a very important consideration for a large percentage of steel mill

Figure 1 — Setups for spraywelding can be conveniently made on the lathe.

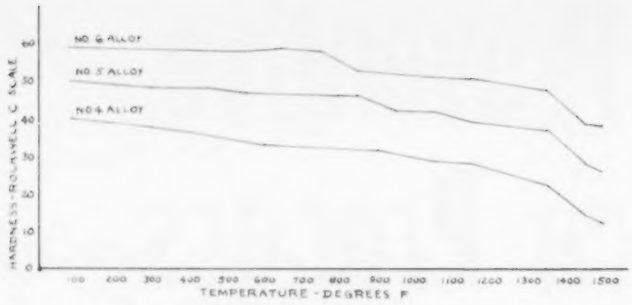


Figure 2 — Red hardness curves for the No. 4, No. 5 and No. 6 alloys.

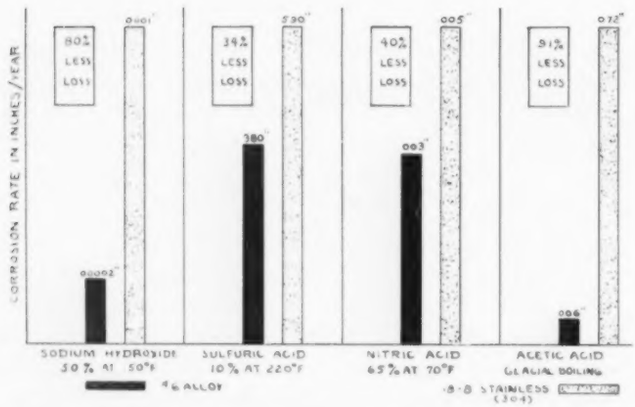


Figure 3 — Bars give comparative resistance to corrosion of alloy No. 6 and 18–8 stainless steel.

applications. The red-hardness curves in Figure 2 show the approximate hardness of the No. 4, No. 5 and No. 6 alloys at temperatures up to 1500 F. It should also be pointed out that an application involving a heating and cooling cycle will not anneal the overlay since the alloys always retrace the same cooling curves.

The superior resistance to corrosion of the No. 6 alloy makes it extremely attractive for applications where practically any type of corrosion is a problem. Figure 3 indicates the comparative resistance to corrosion of alloy No. 6 and 18–8 (type 304) stainless steel.

Table II sets forth the approximate coverage which may be expected from the three alloys, neglecting losses. For example, a pin 3 in. in diameter and 12 in. long will require approximately one pound of the No. 6 alloy at a depth of $\frac{1}{32}$ in. The cost of the powder for this application would be about $6.00.

TABLE II

Coverage in Sq In. per Lb of Powder

Overlay thickness, in.	No. 4 alloy	No. 5 alloy	No. 6 alloy
$\frac{1}{32}$	107	108	113
$\frac{1}{16}$	53	54	56
$\frac{3}{32}$	35	36	37
$\frac{1}{8}$	26	27	26

METALS THAT CAN BE SPRAYWELDED

Many metals can be spraywelded without special precautions, while others require special cooling procedures or special heat treatment to prevent cracking of the overlay.

The following is a partial list of base metals that can be spraywelded without special precautions:

SAE steels below 0.25 per cent carbon content
1000 Series
1200 Series
1300 Series
4000 Series
4100 Series
5000 Series
5100 Series
6100 Series
8600 Series
8700 Series
300 Stainless series (except 303)
Gray cast iron
Meehanite iron
Malleable iron
Ingot iron
Wrought iron
Copper
Nickel
Monel
Inconel
Nichrome
Chromel
Most high temperature alloys

Because of the high coefficient of expansion of austenitic 300 series stainless steel, it is advisable to preheat the part to 400 F prior to spraying. The preheat will expand the part sufficiently to prevent the expansion and contraction from breaking the mechanical bond prior to fusing.

The following group of steels require a 500 to 700 F preheat prior to fusing the overlay and slow cooling after fusion:

SAE steels above 0.25 per cent carbon content
1000 Series
1200 Series
1300 Series
4000 Series
4100 Series
5000 Series
5100 Series
5200 Series
6100 Series
8600 Series
8700 Series
9200 Series

When spraywelding air-hardening tool steels and the SAE series martensitic stainless steels, preheating is required prior to fusing the overlay, and isothermal cooling after fusion is necessary to prevent the overlay from cracking.

APPLICATIONS

1. Table roller and shafting journal sleeves.

These sleeves are manufactured by spraying 0.025 in. per side of the No. 6 alloy on low carbon seamless steel tubing, fusing in an atmospheric furnace and grinding to size. Figure 4 shows, from left to right, the tubing cut to length, shotblasted, sprayed and fused, and finally

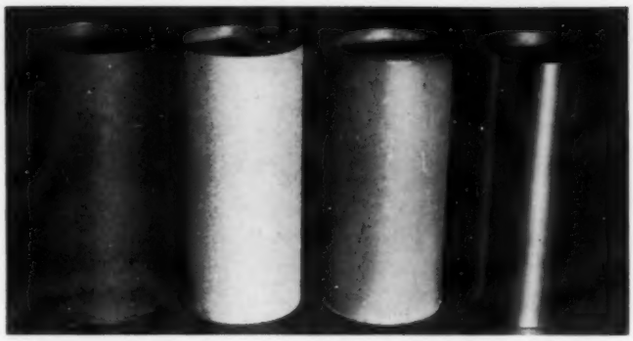


Figure 4 — Journal sleeves are made by spraying hardface material on low carbon stainless steel tubing.

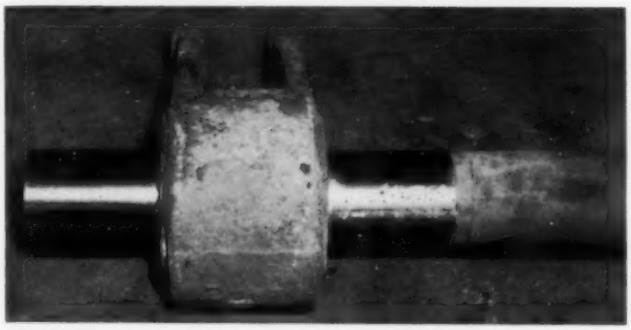


Figure 5 — In making a split sleeve, a solid sleeve is made and then split into two halves.

the finished sleeve. The finished cost of a typical sleeve manufactured in our shops is $30.00, compared with $120.00 for a purchased centrifugally cast sleeve.

Sleeves of this type are shrunk on machine parts, which are subjected to abnormal wear conditions, in order to increase the service life of the part, as well as the brass bearing in which it operates. From studies taken on table roller journals in the 44-in. mill at Steelton, it was found that the cost to maintain one table roller journal, and brass was $21.06 per month. The same study showed that a roller journal, equipped with a hardened sleeve, as described above, costs only $1.50 per month to maintain, including the initial cost of the sleeve.

2. Split journal sleeves.

Split journal sleeves are manufactured under the same procedure as a solid sleeve, and then split into two halves for installation purposes. Sleeves of this type are used for applications where the design of the part does not allow for shrinking a one piece sleeve on the journal, such as the example shown in Figure 5. The sleeve is placed on the undercut journal, clamped in position and the two halves welded together with 420 stainless wire. Excess weld metal is then ground off by hand. This application has been particularly successful on kick-up lever shafts at the 44-in. mill but cannot be recommended for machine parts operating at high speeds.

3. Gas engine valves.

The valve seats and stems of these valves are being treated with an overlay of the No. 6 alloy, as shown in Figure 6. The application has been made to both new and old valves. The past practice had been to hard face these areas with stainless steel (submerged arc process); however, spraywelding is replacing this method for the following reasons:

a. The No. 6 alloy will wear as long or longer than stainless steel.
b. The application of sprayweld alloy may be made in less than half the time required for the application of stainless steel.
c. Finishing time is greatly reduced because excess material for finishing may be held to 0.010 in., while with stainless steel applied by the submerged arc process it is $\frac{1}{16}$ in. or more.

4. Hot blast valve seats for blast furnace stoves.

The inside surfaces of these valve seats, Figure 7, are subjected to corrosion from canal water. This corrosion greatly reduced the service life of the valves and, therefore, a definite maintenance problem existed. To eliminate or slow down the corrosive action, these valve seats, which are made in two halves, have been spraywelded on the inside surfaces before they are welded together. The thickness of the overlay is approximately 0.015 in. Results of the initial service life test on this problem are not complete; however, with experience gained on other applications, which were of a corrosive nature, it seems safe to estimate that these valve seats will have an increased service life of at least five times that of uncoated valve seats.

5. Pins of all types and swing grinder pulleys.

Pins of all types, which are subjected to abrasive and corrosive wear, are now being hard faced by spraywelding. This includes eccentric as well as straight pins.

Swing grinder pulleys, shown in the center of Figure

Figure 6 — Use of hardfacing on valve seats is an economic maintenance procedure.

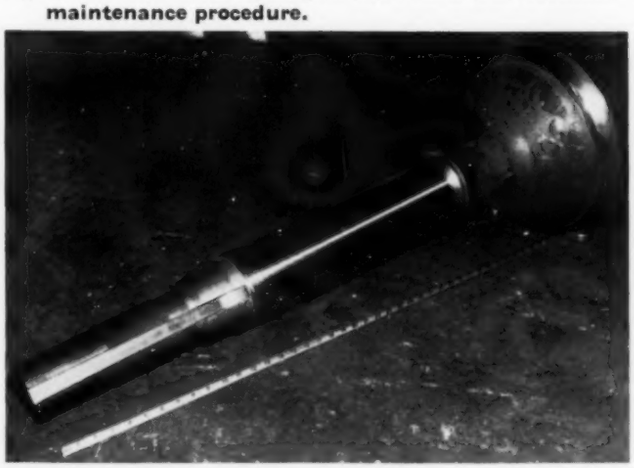


Figure 7 — Spraywelding on hot blast valve seats slows down corrosive action.

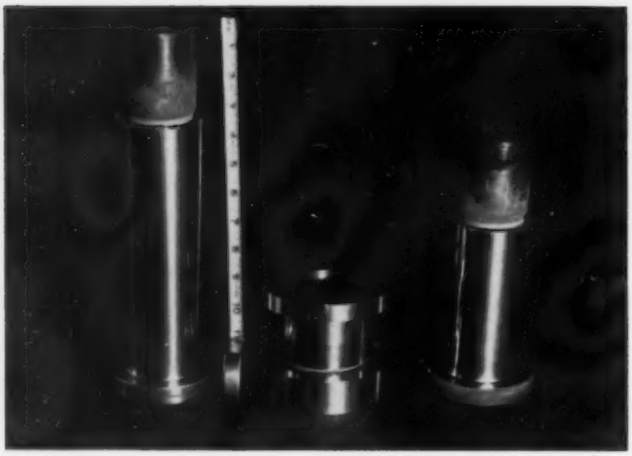


Figure 8 — Pins are a good application for spraywelding buildup.

8, used by the frog and switch department, had a maximum service life of five months before the contact area was hard faced. For an additional cost of $5.00 per pulley, they are now spraywelded. The first hardfaced pulley has been in service one year and still does not show any appreciable wear.

6. Packing gland bolts—44-in. mill shear plunger assembly.

These bolts as shown in Figure 9 are forged from 4140 steel and are 1½ in. in diameter. They are subjected to the action of corrosive water under the head. This critical area under the head is now hard faced with the No. 6 powder to prevent corrosion. After the bolts are spraywelded and fused, they are heat treated by quenching in oil at 1550 F. The finished product is a heat-treated bolt protected from corrosion, which consequently greatly increased its service life.

7. Cast iron steam valves.

Several cast iron steam valves used in steam hammers

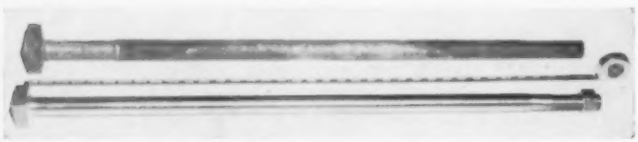


Figure 9 — Packing gland bolts are hardfaced under the head.

have been repaired by building back to size with the No. 6 powder. The overlay has been successfully bonded to the cast iron base metal. The chromium, nickel, boron wearing surface provides a wear and corrosive resistant surface, while the desirable qualities of the cast iron valves have been retained.

8. Induced draft fan impellers.

The vanes and rivet heads of fans subjected to abrasive wear may be hard faced readily with the sprayweld process. In the case of induced draft fans, the wear area is coated with 0.015 in. of the No. 6 alloy by using the gun as you would a paint sprayer. After the coating is applied, an oxygen-acetylene torch is used to fuse the overlay to the base metal. The resultant job requires no finishing and no rebalancing of the fan. It will be sometime before the amount of increased service life may be reported; however, from experience gained with similar applications, an increase of at least five times is anticipated.

SUMMARY

1. The sprayweld process involves three basic operations:

   a. Preparation of the surface.
   b. Spraying the surface.
   c. Fusing the overlay.

2. Finishing the fused overlay may be most satisfactorily accomplished by grinding; however, machining with carbide tools will also produce satisfactory results.

3. The three grades of sprayweld powder mentioned above are nickel, chromium, boron alloys, with a hardness range of 35 to 61 Rockwell C, depending on the alloy used.

4. Advantages of the sprayweld process:

   a. Less time is required to spray and fuse than to apply the overlay with a rod. Less time is required to finish the spraywelded part because the overlay is smooth and much closer to finish dimensions than a hand- or machine-welded part.
   b. Less material is used with spraywelding, than with hand or machine welding, because the thickness of the overlay may be controlled to within 0.010 in.

5. The applications mentioned are only a few of the many to be found in steel plant maintenance operations.

6. The quality of the finished job obtained with the sprayweld process will be in direct proportion to the accuracy with which the basic instructions furnished by the manufacturer are followed. The sprayweld process is an economical and very rewarding method of hard facing; however, short cuts to the end result are impossible.

DISCUSSION

PRESENTED BY

ROBERT TURNER, Electrical Engineer, United Engineers & Constructors, Inc., Philadelphia, Pa.

J. R. SMITH, Development Engineer, General Mechanical Dept., Bethlehem Steel Co., Steelton, Pa.

E. C. PETERSON, Vice President, Rolling Mill Equipment Div., Birdsboro Steel Foundry and Machine Co., Birdsboro, Pa.

L. G. COSCIA, Squad Leader, Bethlehem Steel Co., Sparrows Point, Md.

P. H. PUTNAM, Fluid Control Co., Inc., Philadelphia, Pa.

C. E. PRITCHARD, Superintendent of Mills, Alan Wood Steel Co., Conshohocken, Pa.

Robert Turner: A number of years ago they used wire. Has that been now superseded by the powder?

J. R. Smith: I believe Mr. Turner is referring to the metallizing process. If so, I would say the answer to the

question is no. Both powder and wire are available for metallizing, while only the powder is available for spraywelding. Of course, in the metallizing process, no attempt is made to fuse the overlay to the base metal; therefore, you depend entirely on a mechanical bond to hold the overlay in position.

There are advantages to both methods. A turbine shaft, for example, which is not exposed to impact loading, and which has been heat treated, would be a fine application for metallizing. In this case it would not be advisable to bring the shaft up to fusing temperature because of the possibility of distortion and the changing of physical properties of the base metal. If the application requires protection from impact, spraywelding would be advisable since the overlay can be fused to the base metal.

E. C. Peterson: These comments by Mr. Smith were very interesting and they prompt me to ask a question that always plagues mill operators and builders alike. That is the problem of longer life for roller guides. We have followed the practice of welding on hardfacing materials. The big drawback is that the welding is very rough, and takes a lot of grinding to finish.

Grinding is a difficult job because of the various shapes that are encountered. Does Mr. Smith know whether the process he speaks of has been used in laying the material on roller guides, and if so, what results have been obtained.

One company has recently surfaced some roller guides for us with a flame deposition process, shipped them for installation in a mill for a trial run, but have had no experience as yet. I would like to ask Mr. Smith if the process he is speaking of is similar to this? We obtained a smooth surface on the job that we had done, and it was close enough to dimension, so that no machining or grinding had to be done.

J. R. Smith: In answer to Mr. Peterson's question on roller guides, I would say that in my opinion there is no reason why the hard facing of roller guides would not be an excellent application for spraywelding. Although some consideration has been given to this application at our plant, we have not as yet experimented along this line.

We have used the process on skip bucket guide wheels which so far has done an excellent job; however, final results of the initial installation are not available at this time. The process has also been used on 28-in. rail mill cambering machine eccentric pins which hold the cambering roller in position. There was an outstanding performance on this application.

Mr. Peterson also asked for a comparison of the flame plating process with the spraywelding process. I do know of the flame plating process; however, I have had no experience with it. It is my understanding that tungsten carbide particles are blasted at supersonic speeds onto the surface of the base metal. These particles embed themselves into the surface of the workpiece where a welding action takes place.

L. G. Coscia: I have several questions which I would like to ask about the metal spraying process and spraywelding. In the metal spraying process or in spraywelding, is an alloy bond formed between the base metal and the spray?

Do you heat-treat?

Do you think you might sprayweld the inside of cast iron gate valves which are in contact with salt water, to prohibit graphitization or to slow it down? I would like you to expand on that use if you would, in connection with salt water.

J. R. Smith: The metal spraying or metallizing process depends entirely on a mechanical bond in holding the overlay on the base metal, while in the spraywelding process a molecular bond is created between the overlay and the base metal by bringing the workpiece up to fusion temperature.

You would not heat-treat or fuse aluminum on carbon steel as you would the No. 4, No. 5 or No. 6 alloys.

Cast iron valves may be spraywelded successfully, provided it is physically possible to apply the overlay, and provided the following precautions are taken: first, if the valve had been in service it should be heated to 300 F and held for one hour to remove any oil or grease before spraying; secondly, after fusing at 1900 F, it should be slow cooled at a maximum rate of 200 F per hour to prevent cracking of the overlay.

We have had no experience with applications involving salt water; however, I understand that the resistance to corrosion in salt water of these alloys is extremely high.

P. H. Putnam: Getting back to the valve question, I think I know what Mr. Coscia had in mind. We have problems at Sparrows Point on nickel-iron castings vs the purer cast iron that we are getting today, which results in some corrosion. I would like to ask the speaker to comment briefly on the cost of this spraywelding vs a nickel-iron casting or pure gray iron casting, which is then sprayed. Would the spraying be more expensive, do you think than obtaining nickel-iron castings?

J. R. Smith: In my opinion, the nickel-iron casting would be less expensive than a spraywelded gray iron casting. However, you certainly could not expect the wear, or corrosion resistance, from the nickel-iron casting that would be possible with the spraywelded piece.

In the case of the spraywelded piece, the entire surface to a depth of say 0.040 in. would be a very dense alloy of nickel, chromium and boron, which has excellent resistance to galling, corrosion and abrasion.

C. E. Pritchard: Experience has indicated that the application of a hard surfacing material, by spraywelding or otherwise, entails certain known limitations of dimensional thickness of coating. What are the basic problems involved in reconditioning worn parts?

Are economics a factor, also, in other words, using the cheaper material?

J. R. Smith: The thickness of a sprayweld overlay in our operation is limited to a maximum of $\frac{1}{16}$ in. for two reasons. First, in most cases, the maximum allowable wear is $\frac{1}{16}$ in.; therefore, it would not be economically sound to exceed this limit with hardfacing. Secondly special problems arise when an overlay of over $\frac{1}{16}$ in. is attempted.

In handling the reconditioning of extreme wear cases, the parts are built up to size with medium carbon weld, machined for the desired thickness of overlay and spraywelded. Of course, the pressures to which the parts are subjected in service must be considered, since the base metal must be able to resist these pressures without distorting if the overlay is to be of any value.

. . . . prevention of corrosion in the steel plant is an important and difficult problem. . . . it is particularly important to protect "spares" since such items must be ready for use when needed. . . . protection is relatively inexpensive and may run as low as $0.00035 per sq ft. . . . .

STOPPING CORROSION with rust preventive compounds

By
R. P. MILLS
Manager
Rust Preventive Div.,
Valvoline Oil Co.
Div. of Ashland Oil & Refining Co.
Freedom, Pa.

▲ CORROSION was present as a greenish coating in the bronze and copper ages. In 1400 B.C., it is recorded that a tribe of iron workers lived near the Black Sea, and it is sure that they encountered "rust." From that time until now, this corrosion has been attacking metallic wealth, and at the present rate, it is costing $6,000,000,000 annually.

Of course, man has fought back at this ever-present enemy and has had some success with such methods as: (1) painting; (2) plating; (3) chemical treatments; (4) porcelain enameling; (5) vapor phase inhibitors; (6) specially prepared oils, greases and solvent mixtures.

In order to discuss the use of rust preventive compounds, one must first gain a little insight into the basic electrochemical concept of corrosion.

In order for corrosion to proceed, there has to be set up an electrochemical cell consisting of four parts: (1) anode, +; (2) cathode, −; (3) electrolyte, solution; and (4) connecting circuit.

Anode and cathode are two Greek words that mean positive and negative terminals.

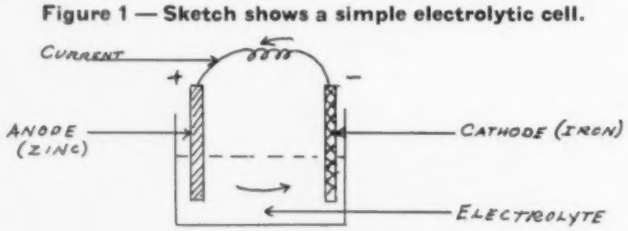
"Electro," also from the Greek, gives the word electrolyte which is merely the water through which electric current flows from anode to cathode.

Flow of current is from the positive or higher potential (anode) through the electrolyte to the negative or lower potential (cathode), and back to the anode by the connecting circuit.

Figure 1 shows a simple cell which illustrates graphically the terms used.

This simple electrochemical cell is commonly called a "galvanic" cell after Galvani who, when hanging dead frogs by copper hooks on an iron rack, noticed a twitching or contraction of the muscles of their legs. This was due to his accidental connection of certain nerves and muscles of the frogs in a metallic circuit.

Figure 1 — Sketch shows a simple electrolytic cell.



Another example of this phenomena (Figure 2) is the flash light battery wherein the carbon is the cathode and the zinc outer shell the anode and, therefore, the corroding member.

Corrosion is always at the anode and where the current enters the electrolyte. Metallic ions there released into solution result in rust and pitting.

The purpose of any protective coating is to interfere with the electrochemical or galvanic cell.

The writer mentioned previously the staggering cost of corrosion. Everyone is familiar with this wholesale destruction, seen in the red oxides of iron or steel, the green carbonate of copper, the white oxide of zinc, commonly called "white rust" and many others.

In practically all the examples cited above, the destruction of the metal is caused by the combination of that metal with oxygen or carbon dioxide of the air. Most engineers are acquainted with the harmful results obtained from the oxidation of lubricating oil in the formation of resins, acids and sludges. It is this oxygen that is the instigator of many corrosion problems.

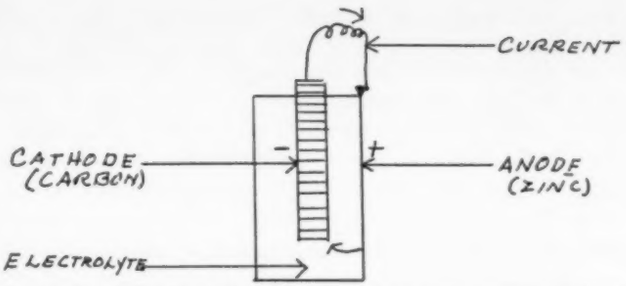


Figure 2 — The flashlight battery is a common example of an electrolytic cell.

Taking iron as the most common example, the reaction equation may be chemically expressed as:

$$2Fe + H_2O + O_2 \rightarrow Fe_2O_3 + H_2$$

Iron + Water + Oxygen = Rust

The peculiar condition surrounding this reaction is that oxygen and iron will not chemically combine with each other if the iron is placed in an atmosphere of anhydrous (dry) oxygen. If one introduces a bit of moisture into that system the reaction starts and rust results. In other words, the water acts much like a catalyst to promote the union of iron and oxygen.

It is believed that the water promotes the chemical reaction by the method shown in Figure 3.

The oxygen is dissolved in the water and this water layer adheres to the metal surface in such a manner as

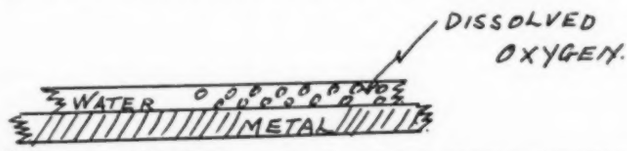


Figure 3 — Dissolved oxygen in water causes corrosion probably because it gives sufficient time for the reaction to take place.

to allow the oxygen to remain long enough to cause corrosion.

Another method of corroding metals, that is much more severe than rusting, is the exposure of metallic surfaces to acid fumes. Iron reacts with hydrochloric acid, a common pickling acid as follows:

$$Fe + 2HCl \rightarrow FeCl_2 + H_2$$

Iron + Hydrochloric Acid → Iron Chloride

This metal-acid salt (i.e. iron chloride) reacts in turn with moisture to form a metal hydrate or hydroxide which finally dehydrates (drip-out) to form rust.

In industrial areas, the burning of coal and oils containing sulphur causes large amounts of sulphur dioxide and sulphur trioxide to be forced into the atmosphere. These gases combine with the water vapor to form sulphurous and sulphuric acid.

$$2S + 3O_2 \rightarrow 2SO_3$$

Sulphur + Oxygen → Sulphur Trioxide

$$SO_3 + H_2O \rightarrow H_2SO_4$$

Sulphur Trioxide + Water → Sulphuric Acid

It has been established that in the City of Philadelphia every 24 hours there is formed and deposited several thousand tons of these acids.

Rust or corrosion prevention is the science of metal protection by the use of applied coatings or chemical treatments. There are many methods of accomplishing this protection which can be listed as follows: (1) painting; (2) plating; (3) chemical treatments such as oxide, phosphate or sulphide coatings; (4) porcelain enameling; (5) vapor phase inhibitors; (6) special types of easily removable coatings including oils, greases and solvent mixtures.

The first four procedures are permanent coatings, and if removed destroy the dimension of the product being protected.

Petroleum-base products are frequently desirable for use on machined surfaces because their less permanent action is offset by such advantages as economy, ease of application and removal when necessary, simultaneous protection and lubricating action.

For many years, straight oils, petrolatums, greases or a combination of petrolatum and oil called "slushing oils" were used to provide a film or layer to protect against corrosion. At the best they were undependable since they only acted as "mechanical barriers" to the entrance of moisture laden air to the metal surface.

In the late 1930's, research by various agencies indicated that the protective life could be greatly increased by the use of special types of additives in the oils, greases and petrolatums.

These additives are generally classified as being "polar" in nature and thus exert a greater attraction for the metal surfaces than water.

"Polar" may be explained as follows: All metals have an inherent electrical charge because of the magnetic lines of force that encircle the world. Metals, while being formed and worked, are stressed and strained and take on a positive (+) or negative (−) charge.

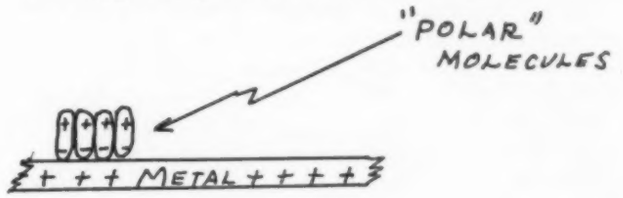
The "polar" type molecules are believed to be elongated or "cigar shaped" with the positive charge at one end and the negative charge at the opposite end (Figure 4). These "polar" molecules are electrically attracted to the metal and form a tightly adhering protective film on the surface to be protected.

Since there is a greater degree of attraction between the "polar" rust preventive and the metal than there is between water and the metal, the water containing dissolved oxygen is forced away from the surface before it can start its destructive action.

An example of the efficiency of these "polar additives" may be best illustrated by a simple laboratory test.

If a steel panel is coated with straight 100 viscosity mineral oil and placed in a humidity cabinet maintained at 100 F and 100 per cent relative humidity, rust spots will develop within three or four hours. If we take this same oil and add to it approximately 10 per cent of "polar" additives, the humidity cabinet life will be

Figure 4 — Polar molecules in materials help by keeping the oxygen away from the surface to be protected.



in excess of 30 days or 720 hours. In other words, the protective life of the oil has been increased by 180 times.

Petroleum rust preventive compounds may be divided into three general classifications: (1) solvent cutback compounds, (2) rust inhibited oils, (3) hot dip waxes or greases.

Grease type preservatives include the thick or heavy coat compounds which will not melt or flow at ordinary room or factory temperatures. Obviously this covers quite a range of materials from the very soft grease or petrolatum type compounds, through the very heavy, hard, wax-like products. These compounds are practically always applied to the metal surfaces by dipping the parts in tanks containing the corrosion preventive in a molten state.

Oil type preservatives include the non-drying, non-setting type of materials. This division includes various weights or viscosities of oil, and even with the heaviest of oils, the protective films will not exceed one or two-thousandths of an inch in thickness.

The protection time obtained from these inhibited oils is good and will be adequate in less exposed areas. However, exposure outdoors under more severe conditions will require added protection, such as additional packaging.

Solvent cutback preventives can be conveniently subdivided, according to the type of material dissolved in the solvent: (1) dry type film, (2) oil or grease type films, (3) water displacing compounds, (4) fingerprint removing compounds.

A property in common for these various subdivisions is the ease of application either by dipping, spraying or brushing at room temperatures. Likewise, they all attain their final coating thickness by evaporation of the solvent from the film.

The leader in the development of protective coatings from petroleum products has been and continues to be the Department of Defense, and their various laboratories such as the U. S. Naval Engineering Experiment Station, Naval Air Material Command, Wright-Patterson Air Force Base and Rock Island Arsenal. These laboratories are not duplicating their work since the Navy is custodian of the solvent cutback specification MIL-C-16173A; the Air Force the fingerprint remover specification MIL-C-15074A; the Army the petrolatum specification MIL-C-11796A and various oil specifications MIL-L-21260, MIL-L-3150, MIL-L-644a, etc.

In conclusion, it might be well to mention the laboratory tests used to evaluate protective coatings. These tests are accelerated procedures and do give a degree of correlation between laboratory protection and actual service life.

The three basic tests are: (1) salt spray, (2) humidity cabinet, (3) weather-o-meter.

The salt spray may be either 4 or 20 per cent salt and is used to evaluate solvent cutback preservatives primarily designed for outdoor service.

The weather-o-meter consists of an ultra-violet light unit in conjunction with water spray to develop the conditions experienced in outdoor exposure of alternate sunlight and rain. This apparatus measures the effect on the protective film of alternate heating and cooling or expansion and contraction of that film.

The humidity cabinet in actuality is a continuous rain storm and is used to measure the efficiency of oil type preservatives.

Rust preventive compounds are inexpensive to use since they are easy to apply and to remove and do stop corrosion from taking place. If one assumes an average cost of $0.70 per gallon and divides this figure by an approximate coverage of 2,000 sq ft per gal, the cost of protection per sq ft is $0.00035.

DISCUSSION

PRESENTED BY

ANDREW CICHELLI, Lubrication Engineer, Bethlehem Steel Co., Construction Engineering Dept., Bethlehem, Pa.

R. P. MILLS, Manager, Rust Preventive Div., Valvoline Oil Co., Div. of Ashland Oil & Refining Co., Freedom, Pa.

Andrew Cichelli: The following comments are primarily based on some field experiences that brought forward a number of difficulties and questions to be answered.

The first experience was that of an armature that we had stored, on a specially built flat car, and presumably adequately protected with rust preventives. Storage was on the outside, but the journal surfaces were protected not only by the rust preventive itself, but by being completely enclosed under a special covering.

After five years of storage the armature was needed at one of our plants. The first trouble occurred on the journals of the car itself. Though protected by the prescribed procedure (the car having been jacked and the journals coated) all journals exhibited scattered rust spots. The car inspector condemned the car and demanded a complete regrinding and burnishing of the journals before the car was released. After a week's delay, the armature was finally delivered to its destination. Upon removal of the exterior wrappings and the protective material, it was discovered that the entire lower surface was covered with rust and pits. Somehow, moisture was trapped under the coating where the armature was held in its supports.

Upon reflection, there was only one definite conclusion—the rust protective material did not stand up under the conditions.

That experience, and many others, confirmed the results of tests that we were conducting on the side with numerous rust preventives, simulating the conditions of outside storage. This is a prevalent practice in the mills, i.e., machined surfaces are coated and exposed to the dust and fumes of a steel mill atmosphere, as well as the elements.

Most of the materials that were tested in this program passed military specifications with flying colors, but failed miserably under our conditions and in our test work. Every test piece was examined and there was not one preservative that gave protection beyond five months. Now, I do not mean that the situation was so bad that the surfaces were beyond usability. I do mean, however, that staining was evidenced as early as the first month and that in the fifth month some of the samples had developed pits. Many of these materials had met military specifications. I will concede we may not

have used laboratory techniques to prepare the samples, but when we saw the failed armature journals, we were convinced that our tests were valid.

It seems that present day products just do not seem to satisfy our conditions.

May I ask a few questions at this point?

You mentioned that polar compounds attach themselves to the metal surface, regardless of the polarity of the metal surface. If stress and strain has an influence on what that surface polarity might be, after a couple of years on the outside exposed to atmospheric conditions, would it be possible for the surface to reverse its polarity, thereby requiring reversal in the polarity of the rust preventive?

If this could happen, would it not affect performance of the rust preventive?

What causes deterioration? Certainly, if we can assign the cause, we may get to the bottom of our troubles. Bearing in mind that I am still only concerned with steel mill atmospheres and effect of the elements, basically what is the nature of the deterioration of the product under these conditions?

How necessary are supplementary wrappings? What types must we avoid? Did you, in formulating these compounds, differentiate between protecting against stain and rust? Stain, as I understand it, would be a salt of iron, not its oxide.

Another question has to do with protecting the surfaces as they leave the machine shop. Many shops use various types of cutting compounds. Most of them contain chlorine or sulphur. Must certain precautions be always taken before application of rust preventives to prevent attack by these elements?

Is there anything that we must do to prepare surfaces that will make the rust preventives more efficient?

Finally, what would you say would be the effect of thickness in a properly applied coating to a properly prepared surface?

R. P. Mills: Mr. Cichelli has covered many of the problems that we face today, and each one of them in itself is a long-term research program, and also a subject for presentation of a paper.

Let us take them one at a time.

We are concerned about the stain problem. Most of our rust preventive compounds, as formulated today, contain a certain amount of what we call mahogany soaps or sodium or calcium sulphonates. The mahogany soaps are made in the white oil industry. We are all acquainted with white oil or mineral oil. It is used in the medicinal work. You can make that oil by taking a proper viscosity product and treating with sulphuric acid. Sulphuric acid removes the color bodies and gives you a clear, white oil. It is a sulphonation of the unsaturates, as we call them. The double bond or triple bond compounds found in all petroleum compounds when sulphonated are black. You neutralize the black compounds with caustic soda or calcium hydroxide. Then this mixture is leached with either isopropyl or methyl alcohol and a molasses-like product is extracted, amber in color, that gives the polarity in rust preventives.

The United States Naval Research Laboratory at Anacosta, Maryland, has carried on a tremendous research program and found there is a tendency for some of the sulphonates to break down. Whether they form sulphuric acid or not, we will not say, but they cause a staining problem. Therefore, we have started to use the synthetic as sulphonates prepared from dodecyl benzene. In other words, we start out with, instead of a mineral oil, a pure organic compound and sulphonate the compound, and these synthetic sulphonates have a tendency to overcome the staining problem. It is an ever-present problem.

Andrew Cichelli: Is it possible for metal polarity to reverse itself in storage, due to expansion and contraction?

R. P. Mills: I would have a tendency to believe that it might be possible, that the polar molecules, as we know them, would tend to reverse themselves underneath the protective film.

Someone is going to ask the question: How do you know the polar molecules have a polarity? In physics or advanced chemistry we have a constant, we call the dielectric constant, and this is the measure of the turning of molecules on an axis. For example, the common benzene radical is written with a carbon, and the hydrogens attached in a certain manner. There is a turning point, and therefore a tendency for that molecule to turn down on its axis. That can be measured electrically and one can calculate what we call the dielectric constant.

We know such polar molecules do have electrical charges and that they have a tendency to turn on their axis so, therefore, I believe they can reverse themselves. We all agree that all metals have an electric charge. For example, I mentioned the Navy having trouble with ships. At the storage basin in the Philadelphia Navy Shipyard, in the mothball fleet, they will pull one ship in right next to another ship, and they do have different charges on them, and there is a tendency for the iron to pass through the salt water and electrolyte to the other ship, from the anode to the cathode. One ship will be corroded and the other will build up.

The Navy makes use of cathodic protection and they add a zinc electrode between the ships. This electrode is attached more easily than the iron or steel and thus protects the steel of the ship.

You asked about deterioration of rust preventive compounds on surfaces. That is a possibility, because as we know rust preventive compounds, they are petroleum products. Petroleum products have only a certain usable life and they tend to oxidize. Therefore they can deteriorate. After a certain length of time, there is no doubt, that protective film can be destroyed. What that reasonable time is would vary from condition to condition, depending upon atmospheric conditions, sunlight or rain and so forth.

We attempt to build up the storage life of those preventive compounds by the use of oxidation inhibitors. They are complex organic compounds put into the mixture, and I believe I am correct in stating that oxidation compound works this way, in that it is attacked first by the oxygen, leaving the petroleum product free. The Department of Defense, in choosing industrial sites for storing the machine tools, recommends that they be inspected thoroughly every six months.

Somebody is going to say that is an expensive process. It is not expensive when you compare it to the original machine cost and the time and what it would cost to

put it back into service if it were covered with rust.

We realize that rust preventive compounds are not the final answer. They are a step in the right direction.

You ask about wrappings. It is always best, if you can, to wrap your various parts that are being protected. That wrapping is nothing more than an outside barrier to protect the machines or tools from the atmosphere. If you have a machine shrouded in paper, you have actually a place where it can breathe in the hot air of the day and the water-laden air will be expelled out; at night, when it cools off, it will be drawn back in. The thing will actually breathe, so the rust preventive compound is very effective, in that it keeps the machine from rusting.

On what type of paper to use, I am not a paper man. I do know we had a new problem recently in the packaging of bearings. A company was packaging lead-babbit bearings and they were using paper or cardboard cartons. The bearings were slushed with a rust preventive compound. After long-term storage, the bearings were stained. We investigated the problem thoroughly and found out it was due to an acid condition, the box had a pH of about 4.5, and with the conditions they had existing in that area this year, it caused the staining problem to start. The boxes were actually wet on the shelf, leaching out the acid ingredients and causing stain. The rust preventive compound was not a thick film but a very thin oil dip and did protect the life for a certain length of time, then it deteriorated. We recommended the use of a neutral container and the problem was solved.

You asked about the removal of the coating. It is very important that all metal surfaces be properly cleaned before the rust preventive compound is applied. Rust preventive compounds will not remove cutting oils; that is, salts left behind by the cutting oils. You mentioned chlorine and so forth, so most of your cutting compounds have to be removed with clean solvent or trichloroethylene to take the contaminants away, because we do know that chlorine with water will form hydrochloric acid and will stain, and etch.

Also, if you use a water soluble emulsion cutting oil, this water left behind often causes trouble.

Somebody will take exception and say many of the soluble oils on the market are rust preventives. They are to some extent, because the soluble oils use the same sulphonates as an ingredient but they have only a very limited surface life. The water that is present does the damage to the machine surfaces.

I can only cite this example by a case history of a railroad car manufacturer who called us in one day and had 10,000 car axles piled up, every one of them rusted. He said, "We put a rust preventive on."

I said, "What did you use, an oil or rust inhibited oil?"

"No, just a plain machine oil."

"How do you grind your wheels?"

"With a grinding wheel with a coolant water passing over."

That was the answer to the problem. The water was left on the surface of the metal. The oil was not displacing the water. It was sticking under the oil.

I said, "There is nothing we can do to save the 10,000 axles. Take them back and machine them." I recommended a water-displacing compound, a surface active material, and said, "If you will apply that immediately after your grinding operation the water will be removed and you will have no trouble."

Typical of a lot of manufacturers, they did it, but never reported the results back to us. I finally saw one of the foremen in the shop and obtained the information that it did work.

I mentioned before that there is a certain amount of a mechanical barrier in all of these rust preventive compounds. A mechanical barrier has a thicker film for the water vapor to pass through before it gets to the metal, but a metal will only hold so much compound. If you get it on too thick and your temperature gets up high enough for the film to start to flow, it will come off and you will find areas completely void of the grease. Therefore you have to maintain a minimum film, so that it does not pull away from the metal surface.

AISE ANNUAL CONVENTION

GOLDEN 50 YEARS ANNIVERSARY

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. . . . many benefits have resulted from a standardization program set up by Wheeling Steel . . . . standardization of lubricants and lubricant equipment has resulted in cost savings, reduced storage space, reduced deterioration of stock and simplified training of the men . . . .

Standards and Classification of Lubricants for Steel Mills

By

J. D. LYKINS

Chief Lubrication Engineer

Wheeling Steel Corp.

Wheeling, W. Va.

▲ SUBSTANTIAL dividends are possible to steel mill operators through standardization, and many operating problems can be simplified. Industry has realized the importance of standardization for many years. Railroads have standardized on track widths, hookups and switches so that travel from one system to another can be made without confusion or delay. Standards have been established for currents and voltage in the electrical field. In the steel industry, standards have been set up for pipe sizes, gages of sheet steel, shipping and packaging of steel and many other items too numerous to mention.

Realizing the importance of standardization, the management of Wheeling Steel Corp. appointed an executive committee to study and develop a standards program. Various subcommittees developed standards and specifications for paints, paper, lubricants and other items in common use.

The subcommittee appointed to develop standards and specifications for lubricants consisted of the lubrication engineer from each plant, representatives from the purchasing department and lubricant testing laboratory, the standards engineer and chief lubrication engineer.

The first step in establishing these standards was to make complete lubrication surveys of all mills and factories in the corporation. Survey information included equipment, bearing type, gear data, method of lubrication, type of lubricant being used, brand name of lubricant, supplier and schedule of lubrication.

From this survey, we were able to classify all products as to type, such as red engine oil, cylinder oil, turbine oils, etc. This survey included lubrication oils and greases, hydraulic oils, solvents, process oils and fuels. To our own amazement, we found over 400 different branded lubricants being used in one plant. Also, we were purchasing from approximately 60 different suppliers. Today this plant has 48 lubricants which include 20 oils and 28 greases, and approximately 95 per cent of all the equipment is lubricated with 9 or 10 of these.

Before going into the classification of lubricants, an explanation of our numbering system is in order. The Wheeling Steel numbering system is patterned after the Dewey decimal system. The first digit represents ten (10) classifications; The second digit represents ten (10) divisions of the classification; The third digit represents ten (10) subdivisions of each division. Use of a decimal point after the third digit permits further subdivision for our system.

We shall use a purchase specification for a lubricant division (listed 212 in our system) and expand it as an example as shown.

First digit	Represents non-metallic material
Second digit	Represents division of non-metallic material
Third digit	Represents lubricants, fuels, process oils, petroleum and synthetic
First decimal digit	Represents class of product
Second decimal digit	Represents type of product
Third decimal digit	Represents subdivision of type of oil
Fourth and fifth decimal digit	Viscosity or consistency
Sixth decimal digit	Service

To illustrate further, let us take Purchase Specification No. PS-212.181211 and break it down as follows:

2	Classification—Non-metallic material
21	Division—Non-metallic material

212. . . . . Lubricants, fuels, process oils——both petroleum and synthetic
212.1. . . . . Lubricating oil
212.18. . . . . Circulating oil
212.181. . . . . Straight mineral
212.18121. . . . . Nominal viscosity at 100 F—601 SSU
212.181211. . . . . Premium quality

The key to the class of product is governed by the first decimal digit.

212.0. . . . . Open
212.1. . . . . Lubricating oil
212.2. . . . . Lubrication greases
212.3. . . . . Fuels
212.4. . . . . Hydraulics
212.5. . . . . Process oils
212.6. . . . . Solvents
212.7. . . . . Synthetic grease
212.8. . . . . Synthetic oil
212.9. . . . . Open

The lubricating oils were classified as to type as shown by the second decimal digit.

212.10. . . . . Open
212.11. . . . . Motor oils
212.12. . . . . Cylinder oil
212.13. . . . . Extreme pressure oil
212.14. . . . . Soluble oil
212.15. . . . . Black oil
212.16. . . . . Open gear lubricant
212.17. . . . . Special purpose oil
212.18. . . . . Circulating oil
212.19. . . . . Open

The types were then sub-typed as shown by the third decimal digit.

212.11. . . . . Motor oil
212.110. . . . . Open
212.111. . . . . ML series motor oil
212.112. . . . . MM series motor oil
212.113. . . . . MS series motor oil
212.114. . . . . DG series motor oil
212.115. . . . . DS series motor oil
212.116 to 212.119. . Open

212.12. . . . . Cylinder oil
212.120. . . . . Open
212.121. . . . . Unfiltered cylinder stock
212.122. . . . . 4 to 6 per cent compounded U.F. cylinder stock oil
212.123. . . . . 8 to 10 per cent compounded U.F. cylinder stock oil
212.124. . . . . Filtered cylinder stock oil
212.125. . . . . 4 to 6 per cent compounded filtered cylinder stock oil
212.126. . . . . 8 to 10 per cent compounded filtered cylinder stock oil
212.127 to 212.129. . Open

212.13. . . . . Extreme pressure oils
212.130. . . . . Open
212.131. . . . . Non-active
212.132. . . . . Active
212.133 to 212.139. . Open

212.14. . . . . Soluble oil
212.140. . . . . Open
212.141. . . . . Straight soluble oil
212.142. . . . . Rust inhibited soluble oil
212.143. . . . . Extreme pressure soluble oils
212.144 to 212.149. . Open

212.15. . . . . Black oil
212.150. . . . . Open
212.151. . . . . Residual
212.152 to 212.159. . Open

212.16. . . . . Open gear lubricant
212.160. . . . . Open
212.161. . . . . Solvent cut back
212.162. . . . . Non-solvent cut back
212.163 to 212.164. . Open

212.17. . . . . Special purpose oil
212.170. . . . . Open
212.171. . . . . Penetrating oil
212.172. . . . . Electrical insulating oil
212.173 to 212.174. . Open

The greases have been classed and typed in a similar manner as shown:

212.2. . . . . Grease
212.20. . . . . Open
212.21. . . . . Cup grease
212.22. . . . . Ball and roller bearing grease
212.23. . . . . Extreme pressure grease
212.24. . . . . Roll neck grease
212.25. . . . . Special purpose
212.26. . . . . Metal working compound
212.27 to 212.29. . . . Open

Each of these classes are broken down in a similar manner as that of oil, as shown:

212.2. . . . . Grease
212.20. . . . . Open
212.21. . . . . Cup grease
212.210. . . . . Open
212.211. . . . . Normal temperature, water resistant
212.212 to 212.219. . Open

212.22. . . . . Ball and roller bearing grease
212.220. . . . . Open
212.221. . . . . High stability
212.222. . . . . Normal stability
212.223 to 212.229. . Open

212.23. . . . . Extreme pressure greases
212.230. . . . . Open
212.231. . . . . Normal temperature, less than 225 F dropping point
212.232. . . . . High temperature 225 F dropping point and higher
212.233 to 212.239. . Open

212.24. . . . . Roll neck grease
212.240. . . . . Open
212.241. . . . . Block grease—high temperature
212.242. . . . . Block grease-normal temperature
212.243. . . . . Graphited grease

High temperature extreme pressure water resistant greases could also be classed in this group.

212.25. . . . . Special purpose grease
212.250. . . . . Open
212.251. . . . . Wool yarn
212.252. . . . . Graphited
212.253. . . . . Silica jell
212.254. . . . . Molybdenum
212.255. . . . . Plug valve

212.256.....Acid resistant
212.257 to 212.259..Open

212.26.....Metal working compound
212.260.....Open
212.261.....Pigmented
212.262.....Non-pigmented
212.263 to 212.269..Open

The fuel oils are classed as:

212.3.....Fuels
212.30.....Open
212.31.....Internal combustion fuels
212.32.....Furnace fuels
212.33 to 212.39....Open

212.3.....Fuels
212.30.....Open
212.31.....Internal combustion engine fuels
212.310.....Open
212.311.....Diesel fuel
212.312.....Gasoline regular
212.313.....Gasoline premium
212.314 to 212.319..Open

212.32.....Furnace fuels
212.320.....Open
212.321.....Bunker "C" fuels
212.322.....Raw natural gasoline
212.323.....Coal tar
212.324.....Butane
212.325.....Propane
212.326.....Kerosene
212.327 to 212.329..Open

Hydraulic oils are classified using different code numbers than those of lubricating oils, their specifications being the same. However, in the scope of the specification their end use is described.

They are classified and typed as follows:

212.4.....Hydraulics
212.40.....Open
212.41.....Synthetic
212.42.....Petroleum oil
212.43.....Soluble
212.44 to 212.49....Open

212.4.....Hydraulics
212.40.....Open
212.41.....Synthetic
212.410.....Open
212.411.....Aqueous base
212.412.....Non-aqueous base
212.413 to 212.419..Open

212.42.....Petroleum oil
212.420.....Open
212.421.....Straight mineral oil
212.422.....Rust inhibited
212.423.....Oxidation inhibited
212.424.....Rust and oxidation inhibited
212.425 to 212.429..Open

212.43.....Soluble
212.430.....Open
212.431.....Straight soluble
212.432.....Heavy duty soluble
212.433 to 212.439..Open

The classifications as to type of process oil are as follows:

212.5.....Process oils
212.50.....Open
212.51.....Coal spray oil
212.52.....Rolling oils
212.53.....Straight slushing oil
212.54.....Soluble slushing oil
212.55.....Terne plate oil
212.56 to 212.59....Open

The classification and type of solvents are as shown:

212.6.....Solvents
212.60.....Open
212.61.....Soluble
212.62.....Straight solvent

After the survey had been completed, all lubricants were classed and typed and numerous cases were found where six or seven brand name products which fell within the same classification and type were being used in one plant.

The problem was then to reduce these products to no more than two. This is where the lubricants testing laboratory is beneficial in determining which of the products are best adapted to our operation. If all of the products being tested prove to be equal in quality, then the product offered at the best price is selected. When price and quality are equal, the problem is left up to the purchasing and sales departments to determine who should get the business.

Standardization in the lubrication division of Wheeling Steel not only includes lubricants but lubrication equipment such as hand guns, grease fitting, transfer and filler pumps, grease packs, centralized lubrication systems, oil pumps, etc. There are a number of advantages to be gained through standardization, namely:

1. Permits buying in larger quantities, resulting in savings in unit cost from volume discounts. Savings of 10 cents or more per gallon on oil can be realized in tank car deliveries and lubrication equipment has similar discounts.

2. Simplifies training programs. One can realize the tremendous problem encountered in training men in the use of 400 different brand products or training maintenance men in the repair of several different makes of pumps, controls or centralized grease systems.

3. Reduces the amount of storage space required. In numerous cases, the amounts of storage space required has been reduced more than 50 per cent. At Wheeling Steel a 30-day supply of lubricant plus the capacity of the largest system is maintained on inventory so the advantages gained can readily be seen. The same holds true in lubricant equipment repair parts.

4. Permits faster turnover of lubricants and equipment, reducing the hazard of deterioration in service. There are some greases that have storage or shelf life of five years or more. However, some type cup and general purpose greases may suffer degradation in much less time. Oils are not usually as critical, but we have seen spare repair parts corroded to such an extent that they were not useable.

5. Eases the problem of inventory, which is apparent.

6. Permits buying to control specification. The lubrication subcommittee through the lubricant testing laboratory and lubrication engineers develops the minimum requirements for a product. The lubrication engineer determines the minimum operating re-

TABLE I
Industrial Lubrication Viscosity Classification, Wheeling Steel Corp.

Ident. No.	Centistokes kinematic			Saybolt universal		
	Nominal viscosity at 100 F	Viscosity limits		Nominal viscosity SSU at 100 F	Viscosity limits	
		Minimum	Maximum		Minimum	Maximum
03	2.0	1.8	2.25	32.6	31.9	33.50
04	2.5	2.25	2.85	34.4	33.5	35.52
05	3.2	2.85	3.60	36.64	35.52	37.90
06	4.0	3.60	4.50	39.10	37.90	40.70
07	5.0	4.50	5.65	42.30	40.70	44.38
08	6.3	5.65	7.15	46.46	44.38	49.20
09	8.0	7.15	9.00	52.00	49.20	55.4
10	10.0	9.00	11.5	58.80	55.4	64.10
11	13.0	11.5	14.5	69.60	64.1	75.3
12	16.0	14.5	18.0	81.10	75.3	89.2
13	20.0	18.0	22.5	97.50	89.2	108.2
14	25.0	22.5	28.5	118.9	108.2	134.3
15	32.0	28.5	36.0	149.7	134.3	167.7
16	40.0	36.0	45.0	185.7	167.7	208.4
17	50.0	45.0	56.5	231.4	208.4	261.3
18	63.0	56.5	71.5	291.2	261.3	330.3
19	80.0	71.5	90.0	369.6	330.3	415.8
20	100.0	90.0	115.0	462.0	415.8	531.3
21	130.0	115.0	145.0	601.0	531.3	669.9
22	160.0	145.0	180.0	739.0	669.9	831.6
23	200.0	180.0	225.0	924.0	831.6	1039.5
24	250.0	225.0	285.0	1155.0	1039.5	1316.7
25	320.0	285.0	360.0	1478.0	1316.7	1663.0
26	400.0	360.0	450.0	1848.0	1663.0	2079.0
27	500.0	450.0	565.0	2310.0	2079.0	2610.0
28	630.0	565.0	715.0	2910.0	2610.0	3303.0
29	800.0	715.0	900.0	3696.0	3303.0	4158.0
30	1000.0	900.0	1150.0	4620.0	4158.0	5313.0
31	1300.0	1150.0	1450.0	6006.0	5313.0	6699.0
32	1600.0	1450.0	1800.0	7392.0	6699.0	8316.0
33	2000.0	1800.0	2250.0	9240.0	8316.0	10,395
34	2500.0	2250.0	2850.0	11,550	10,395	13,167
35	3200.0	2850.0	3600.0	14,784	13,167	16,632
36	4000.0	3600.0	4500.0	18,480	16,632	20,790
37	5000.0	4500.0	5650.0	23,100	20,790	26,103
38	6300.0	5650.0	7150.0	29,106	26,103	33,033
39	8000.0	7150.0	9000.0	36,960	33,033	39,780
40	10,000	9000.0	11,500	46,200	39,780	53,130
41	13,000	11,500.0	14,500	60,060	53,130	66,990
42	16,000	14,500	18,000	73,920	66,990	83,160

quirements in the field and the laboratory determines what tests are necessary to insure the lubricant meeting those requirements. From these requirements, physical specifications are written covering such pertinent data as:

1. Scope
2. Requirements
   a. Compounding
   b. Homogeneity
   c. Qualification tests
3. Penalties
4. Sampling
5. Packaging
6. Marking

The specification is then submitted to the executive committee for its approval and subsequent Wheeling Steel Specifications & Standards.

These specifications are then submitted to the suppliers by the purchasing department. The suppliers submit samples of their products to the lubricants testing laboratory for approval.

To protect the supplier, the last decimal digit was added to designate service, that is, whether the product is of premium quality or a competitive product where price will be of prime importance providing the lubricant submitted meets the minimum requirements. By the same token, if the lubricant is designated premium, performance becomes of prime importance, and lubricants submitted meeting the minimum requirements will be classed as passing approved. The preferred will be those exceeding the minimum specifications, and proving the best in field tests.

The Wheeling Steel specifications are not designed to tell a supplier what to put in the lubricants or how to make them, but are physical or performance specifications, and are designed to take the confusion out of the branding and typing of products used today. Table I shows the viscosity classification we use for oils and at the present time is not held too rigid. The limitations of viscosity from the nominal is defined in the specification. The grease penetration number is the same as NLGI only a zero is added before their designation number, the penetration range remaining the same as shown in Table II.

The management in Wheeling Steel is very hopeful that when this program is completed, many benefits will result.

TABLE II
Grease Penetration, Wheeling Steel Corp.

Ident. No.	NLGI No.	ASTM work penetration at 77 F
00	0	355/385
01	1	310/340
02	2	365/295
03	3	220/250
04	4	175/205
05	5	130/160
06	6	85/115

SILICONE LUBRICANTS for the steel industry

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▲ THE name "silicone" applies to a group of synthetic products which contain silicon, oxygen and various organic groups. The backbone of these materials is a chain of alternate silicone and oxygen atoms joined by the same strong chemical bonds that link silicon and oxygen in quartz. To this chain are added various organic groups, usually methyl and phenyl. Thus, in silicones are found some of the inorganic properties of quartz combined with some of the characteristics usually associated with organic materials. This unusual chemical structure is the basis for a family of products with many unique properties.

Silicones are used in a great many applications, from cosmetics to grease for core oven conveyors. This discussion will deal with silicone lubricants specifically of interest to the iron and steel industry.

PROPERTIES OF SILICONE FLUIDS

Silicones perform well as lubricants under some of the adverse conditions experienced in this field. The remarkable oxidation and thermal stability of silicone fluids have made them useful as lubricants where extremely high temperatures are involved. Because of their good viscosity-temperature characteristics and wide liquid range, these materials perform well at both high and low temperatures. The over-all inertness and incompatibility characteristics of the silicone fluids make them valuable as lubricants where resistance to a variety of materials is important. Some of the properties of these products are outlined in Table I. Fluid A is a dimethylpolysiloxane fluid. It is available in large number viscosity grades, is oxidation stable, and exhibits the best viscosity-temperature properties of any of the silicone fluids. The low phenyl content fluid B has a very low freezing range. In other respects it is similar to fluid A. Although they have poorer viscosity-temperature properties than the others, the medium and high phenyl content fluids C and D show much improved oxidation stability and volatility characteristics. The unique viscosity-temperature characteristics of the silicone fluids are shown in Figure 1.

Just as the physical properties of silicones were found to be different from those of organic materials, so were their lubricating characteristics. In early work it was found that silicones did not provide satisfactory lubrication for ferrous metal combinations in sliding contact. However, they were found to be adequate lubricants for this bearing metal combination when the major portion of the contact was rolling. With other types of bearing situations such as steel against zinc, cadmium, babbit, lead-free brass and all types of plastic materials, in both rolling and sliding contact, silicones have performed well as lubricants.

. . . . chief uses of silicone fluids are in applications where high heat stability is required, where changes in viscosity must be kept at a minimum through a temperature range and where chemical inertness and chemical incompatibility are needed . . . .

PROPERTIES OF SILICONE GREASES

These various fluids are compounded with suitable temperature stable thickeners to form the family of silicone greases. Table II lists the properties of various silicone greases. A methyl silicone fluid is combined with a silica filler to form grease E. This product is chemically inert, and its consistency is stable over a

TABLE I

Classification of Silicone Fluids

Type	Physical state	Phenyl content	Viscosity range in centistokes at 77 F	Useful temperature range, F
A	Fluid	None	0.65 to 1,000,000	−125 to 350
B	Fluid	Low	50 to 60,000	−100 to 400
C	Fluid	Medium	100 to 150	−58 to 500
D	Fluid	High	500	−8 to 500

Typical Physical Properties of Silicone Fluids

Type	Viscosity centistokes at 77 F	VTC*	Pour point, F	Flash point, F	Gel time at 500 F, hr
A	10	0.60	−67	600	24
A	500	0.61	−58	600	24
B	500	0.64	−70	550	400
C	150	0.76	−58	600	750
D	500	0.83	−8	600	1000

* VTC = viscosity temperature coefficient = $1 - \frac{\text{viscosity at 210 F}}{\text{viscosity at 100 F}}$

TABLE II

Classification of Silicone Greases

Type	Physical state	Phenyl content	Thickener used	Useful temperature range, F
E	Grease	None	Silica	−60 to 400
F	Grease	Low	Lithium soap	−100 to 300
G	Grease	Medium	Lithium soap	−40 to 400
H	Grease	High	Carbon black	−20 to 500

Typical Properties of Silicone Greases

Type	ASTM penetration	Dropping point, F	Bleed per cent*	Evaporation, percent*	Maximum operating speed factor***
E	240	None**	1.0	1.5	
F	320	400	3.0	3.0	150,000 to 200,000
G	310	400	2.0	1.5	150,000 to 225,000
H	300	None**	4.0	1.0	75,000

* Bleed and evaporation determined after 24 hr at 300 F in a wire-mesh cone.

** These materials do not fuse because they contain inorganic fillers.

*** Speed factor equals bearing bore in millimeters times speed in rpm

wide temperature range. Greases F and G are both lithium-base ball bearing lubricants. Because the low phenyl content fluid is used in grease F, it is designed for extreme low temperature application. Grease G, made with a medium phenyl content fluid, is useful at higher temperatures. Carbon black is used as a thickener for the high phenyl fluid to form grease H. This product is stable at extremely high temperatures. It is limited to low speed applications. The properties of these greases are directly related to those of the base fluids used in them. This fact is true for lubricity, incompatibility, and other characteristics as well.

Figure 2 compares the oxidation stability of silicone greases with that of two organic greases.

The lithium type silicone greases are often used to lubricate ball bearings operating at extreme temperatures. For the best service with these greases, a few factors should be noted:

1. With few exceptions, the speed factor (bearing bore in mm x speed in rpm) listed in Table II should not be exceeded.

2. The temperature limitations of Table II are for average service. The lubricants can be used above the recommended temperatures with increased relubrication.

3. It is desirable that the radial bearing load be less than one-third the bearings manufacturer's maximum rated radial load.

4. Bearings stabilized for elevated temperature service should be used.

5. Bearings to be silicone lubricated should have adequate internal clearance. Laboratory tests indicate that practical loose shaft fits are a means of obtaining this condition.

APPLICATIONS OF SILICONE LUBRICANTS IN THE IRON AND STEEL INDUSTRY

A widely used application of the medium phenyl content fluid-lithium base grease is the lubrication of silicone insulated Class H electric motor ball bearings. Such motors are designed to operate up to 180 C (356 F). They are used in applications where excessive overloads or high ambient temperatures make the op-

Figure 1 — Curves give effect of temperature on viscosity. Silicone fluids have less variation than the SAE 30 oil.

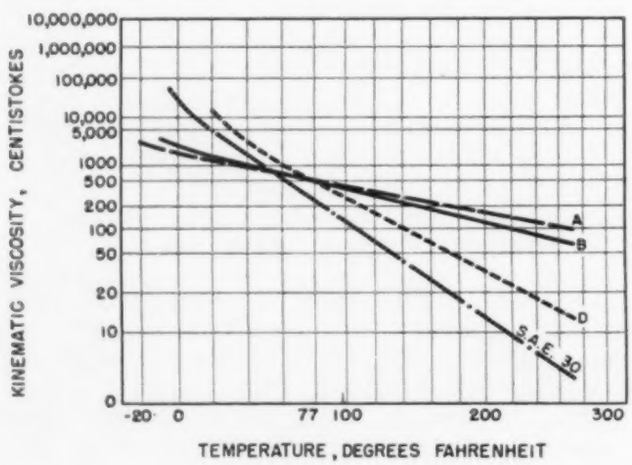
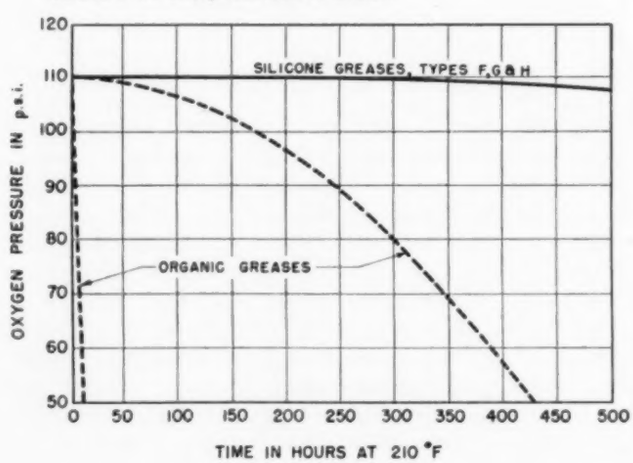


Figure 2 — Curves give relative oxidation resistance of the silicone and organic greases as indicated by changes in pressure within oxygen bomb after heating for 500 hr at 210 F in the presence of brass.



erating temperatures too high for conventionally insulated equipment. The bearings of these motors need thermally stable lubricants if their full performance is to be utilized. In the laboratory tests, Class H motors fitted with 310 and 311 silicone lubricated bearings have operated at 3600 rpm and at 110 C for 14,000 hours without a failure.

Where slow moving bearings are subjected to extremely high ambient temperatures, frequent relubrication, regular maintenance, bearing seizure and high power demands are common problems. In many situations of this type, the carbon black filled silicone grease has overcome these difficulties. A typical example of how this lubricant has helped solve such a problem was found in a steel blooming mill. Difficulty was experienced in lubricating the wheel bearings of the rail car that removed the covers from the soaking pits. During this operation, the wheel bearings were exposed to the heat of the soaking pits. It was estimated that at times the bearing temperatures reached 700 F. In spite of almost continuous lubrication with a high temperature organic grease, these bearings frequently seized, stalling the carriage. Aside from excessive maintenance, these failures caused losses in process time and material.

This cover carriage is now lubricated weekly with the carbon black type silicone grease and no bearing failures have since been reported.

This same grease has been used successfully to lubricate conveyor systems exposed to elevated temperatures. In one foundry, difficulty was encountered with the trolley bearings in a core oven. These bearings were exposed to peak oven temperatures of 700 F for about 2½ out of every four hours. Despite frequent cleaning and relubrication, the bearings froze and the rolling surfaces were flattened. After lubricating with the silicone grease there were no more bearing seizures and lubrication was reduced to once a week.

Plug valves subjected to elevated temperatures or corrosive chemicals have been successfully lubricated with a silicone fluid thickened with a finely divided silica. This type of grease will not be lost from the valve due to thinning by heat. The material is resistant to a variety of chemicals and solvents.

The high phenyl containing fluid is often used alone or to rejuvenate the carbon black silicone grease in lubricating conveyor bearings exposed to high temperatures. This same fluid is also used to lubricate collets that hold parts for plating. The collets are subjected to both high temperatures and corrosive atmospheres.

Silicone based lubricants are being used in a variety of other applications where they are exposed to numerous adverse conditions. Some of the uses reported include the lubrication of the bearings of a directly connected pump operating over molten salt baths used in an austempering furnace, the ball bearings of cupola intake draft fans, the ball bearings on continuous welding machines for steel drums and many others.

These are a few applications where silicone lubricants have helped to alleviate some of the lubrication engineer's worst problems. Silicone lubricants can reduce maintenance by requiring less frequent cleaning, relubrication and bearing changes normally caused by high temperatures. Better performance can be achieved by lower power demand and the use of equipment at full capacity at these elevated temperatures.

FUTURE DEVELOPMENTS

The present goal of research work in the silicone lubricant field is to improve the lubricating qualities of the fluids with ferrous metals in sliding contact. Some progress toward this end has been made. Laboratory tests indicate that some improvement in lubricity is obtained when chlorine is incorporated into the silicone fluid structure.

At present, the temperature limits of silicone greases are imposed by the stability of available thickeners. Better thickeners are being sought so that the potential of the silicone fluid can be realized.

Present work indicates that silicone fluids of even greater heat stability may become available for use as lubricants.

SUMMARY

The remarkable properties of silicone fluids— high heat stability, low effect of temperature change on viscosity, chemical inertness, and incompatibility—make them ideal lubricants for use under adverse conditions.

Silicone greases are compounded with suitable silicone fluids and heat stable thickeners. These greases solve many lubrication problems where extreme temperatures result in organic lubricant failure and consequent excessive relubrication and maintenance. Presently available silicone lubricants are handling a number of difficult jobs in the iron and steel industry. Their unique properties should make them interesting for still other uses. Research in this field promises to produce new silicone lubricants with even more outstanding properties.

DISCUSSION

PRESENTED BY

JAMES F. FOX, Sales Manager, Sendzimir Mill Div., The Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.

P. R. CLEARY, Lubrication Engineer, Warren District, Republic Steel Corp., Warren, Ohio

W. H. RAGBORG, Laboratory Supervisor, Fluids Section, Product Development Laboratories, Dow Corning Corp., Midland, Mich.

James F. Fox: Recent developments in the metal rolling industry have brought about requirements for so-called "medium temperature" rolling.

The specifications covering this class of rolling call for the production of strip or sheets to cold rolled standards as regards to surface and gage tolerances, but at temperatures up to 600 F or perhaps even higher.

The Sendzimir mill, with its small work rolls and rigid design, lends itself to these requirements in many ways. Even the fact that the mill roll components operate in a bath of oil means that mill shape is readily stabilized and as higher temperature lubricants are developed this feature will aid in maintaining an extremely close temperature control of the sheet.

We have been investigating these higher temperature oils in conjunction with "medium temperature" rolling of various titanium alloys and other materials, since the lubricants normally used are only applicable at tempera-

tures up to around 300 F. An oil with fair to good lubricating qualities at temperatures of 300 F and up would be quite interesting to us and we would like to ask Mr. Ragborg if he could outline the work that has been done in this field together with the results.

P. R. Cleary: I think Mr. Ragborg is to be congratulated on a very practical and informative paper on a really new product, as far as my experience in the steel mill is concerned. We do have several applications where silicones are used as he stated in his paper.

I have a question I would like to ask the speakers.

How did they determine the useful temperature range — that is, what laboratory means or field test was used to determine the useful temperature in these products?

To give a little sidelight on the use of the silicones in the blooming mill for soaking pit cover machines, in our experience at Warren, we have had two different types of application. One is a plain bearing unit, which is the older type of soaking pit mechanism, in which at present we use a cylinder stock as journal lubricant. The cylinder stock at the elevated temperature involved is not doing too good a job. However, on brass wheel bearings in the older application it has lasted three to six months.

The other application is relatively new, in that we have an anti-friction bearing on a new installation which at present is using lithium soap. That is a centralized hand lubrication system which has operated up to the present for a period of six months without any failure. They are lubricated twice a week. So far the lithium in that particular case has held out in our experience.

One other thing, is the fact that if we get into some of these applications where we have to use silicones because of the high temperature condition, the factor which involves one-third load limit on the radial bearing is going to be quite involved, since in the steel plant we do not have that type of factor to work with very long. Over a period of a year or two they start overloading that type of bearing to increase production or for some other reason, and I would like to know if there are any comments or discussions as to better development of silicones from a load standpoint.

W. H. Ragborg: The useful temperature ranges we have established on our greases are primarily controlled by the thickeners we use. In the case of lithium base products, we have established 400 F as the maximum range because the lithium thickener begins to melt and decompose in this temperature range. Actual field experience as well as laboratory bearing tests such as C. R. C. and Navy Motor Generator Set Bearing Tests were also considered in establishing useful temperatures.

Our low temperature limits were established using low temperature apparent viscosity and low temperature torque measurements.

P. R. Cleary: I was rather surprised that you were not getting the life out of the lithium that we are. I wonder if I should be looking for trouble.

W. H. Ragborg: That I cannot answer. Our experience has been that applications of this kind vary considerably, and that the conditions in a particular plant may be different. We do know that this particular case was a situation where they were experiencing difficulty. They tried a number of high-temperature greases without much success. It is true that there may be high-temperature applications where you can use presently available organic materials, lubricate them quite frequently and get away without any difficulty. On the other hand, it may be more economical for you to use the higher-priced materials, to reduce your lubrication schedule, and thereby reduce the opportunity for trouble. This is an economic balance that generally is decided specifically on the conditions existing in the particular application involved.

Finally, you mentioned load-carrying capacity. As I mentioned during my discussion, we are very much interested in improving the load-carrying characteristics of these oils, especially for ferrous metals in sliding contact. We have made some progress in this direction but the work is in the product development stage. We can show in laboratory tests that chlorine-containing silicone fluids are superior lubricants for ferrous metals when compared to standard silicone fluids. Realistically, they do not appear to be as good as a high grade petroleum oil in this respect.

Mr. Fox asked a question about high temperature rolling oils. We have not had any experience with this type of application in the steel industry. We have had a little experience in rolling high temperature magnesium alloys. We are fortunate enough to be located across the street from the Dow Chemical Co. where a great deal of work in the magnesium field is done. We can definitely show that the oils tested have better stability than the presently used rolling oils. Field testing should tell us whether or not these materials are adequate lubricants for this particular job.

In the case of steel, I think that the lubricating characteristics of the silicone fluid are probably still too poor to be suitable as a rolling oil for steel. However, this is only an opinion. We do not really have any field experience to back up this statement.

There is constant demand for copies of "The Modern Strip Mill,"

published by the Association of Iron and Steel Engineers.

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ASSOCIATION OF IRON AND STEEL ENGINEERS, 1010 EMPIRE BLDG., PITTSBURGH 22, PA.

SILICONE PROTECTIVE COATINGS for the steel industry

By R. C. HEDLUND
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Product Development Laboratories
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Midland, Mich.

▲ SILICONE resins, like silicone fluids and lubricants, have won wide recognition for their heat and corrosion resisting properties. They have prevented rust from forming on industrial high temperature equipment in some cases for fifty times as long as conventional organic finishes. They have also enabled manufacturers of stoves, space heaters and other appliances to replace their ordinary dull browns and blacks with bright modern colors at no sacrifice in performance or serviceability.

Silicone resin polymers are the backbone of these silicone coatings. Unlike the silicone fluids, which are linear, threadlike materials, the resins are cross-lined honey-comb-like structures. They cure with heat to hard resinous coatings. The properties of the various silicone resins depend upon the amount of cross-linking and the type of organic group that is attached to the silicon atom. Figure 1 describes the chemistry of a silicone resin. By varying the amounts of siloxane monomers, a wide range of resins having various degrees of flexibility and hardness can be formulated.

Along with heat stability, the silicone resins exhibit excellent resistance to weathering, oxidation, ultraviolet light and other destructive elements. Specific resins can be designed to have excellent low temperature characteristics if such properties are required. This resistance to heat and weathering is the primary reason for using silicone-based finishes for protective coatings.

MAINTENANCE FINISHES

In heat resistant finishes, silicone resins may be used alone as the paint vehicle or modified with various organic resins. Generally, the entire vehicle is silicone, but in some cases small amounts of organic resins are used to provide special properties. The most prominent of the silicone industrial coatings are those containing metallic pigments, such as aluminum. The combination of aluminum with silicone resins has given finishes with excellent heat and corrosion resistance. They have been used widely on mufflers, manifolds, industrial stacks and similar equipment where exterior exposure is a problem. Aluminum-silicone coatings provide good to excellent protection in the temperature range of 300 to 1000 F. The most difficult temperature range to protect is 600 to 800 F.

. . . . if heat, weather, or moisture resistance is a problem for a coating, then silicone-based products should be investigated . . . .

This range is above the decomposition temperature of the silicone resin and below the fusing point of the aluminum pigment. To improve the corrosion resistance at these temperatures, a number of primers and finish coats have been investigated. Field and laboratory results have shown that zinc dust-silicone primers are superior in this temperature range and are recommended as primers where these temperature conditions exist.

Finishes based on silicones are identical in appear-

Figure 1 — Chart shows how silicone resins are built up.

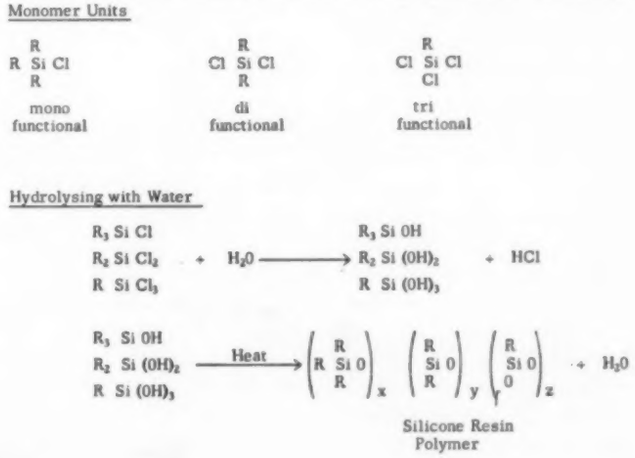

TABLE I

Effect of Metal Base Upon Heat Life of Finishes Based on Dow Corning 802

Metal	Per cent adhesion					
	Hours at 250 C			Hours at 300 C		
	16	40	100	16	40	100
Smooth steel	100	100	100	50	0	0
Sand blasted steel	100	100	100	100	100	100
Aluminum	100	100	100	100	100	100
Magnesium	100	100	100	100	100	100
Copper	5	0	0	0	0	0
Tin plate	100	100	100	100	100	100
Zinc plate	18	0	0	0	0	0

ance to conventional paints. They can be applied by brush, dip or spray. For maximum durability, the coatings must be cured either before or during the operation of the painted equipment. Temperatures in the range of 300 to 400 F are necessary to polymerize the resin sufficiently to give corrosion resistance.

For best results, all metal surfaces should be sandblasted before coating with silicone finishes. The improved adhesion of silicone paints over sandblasted metal is shown in Table I. If sandblasting is not possible, then the surface should be cleaned by wire brushing to remove all old paint and any loose rust or mill scale. Film thickness of silicone-aluminum finishes is also important. Field experience has shown that two coats are preferred, and that one to two mils should be applied.

In many applications colored coatings other than aluminum are required. These colors can be formulated using heat-resistant pigments, such as iron, chromium and titanium oxides. The colored finishes have excellent heat resistance up to 550 F and will provide corrosion resistance along with their decorative appeal. An important property of silicone enamels is their excellent color and gloss retention (Figure 2). This superior gloss and color retention enables heater finishes to maintain a new appearance over long periods.

To obtain a better picture of the type of protection silicone coatings provide, a few examples might help to tell the story.

A few years ago, maintenance men at a large Southern gas pumping company found it impossible to protect compressor mufflers from corrosion. The operating temperature ranged from 400 to 800 F. None of the most heat-resistant organic coatings lasted more than a few months. Approximately five years ago, these mufflers were sandblasted and painted with a 100 per cent silicone-aluminum paint. The coating cured at the operating temperature when the mufflers were returned to service. These mufflers (Figure 3) operated for three years before showing signs of slight failure. Today, they are being touched up annually during the yearly shutdown and have completely resisted corrosion.

Another example is the Cit-Con Oil Refinery near Lake Charles, Louisiana. This plant is one of the largest fully integrated oil and wax plants in the country. The entire plant is finished in a color scheme of aluminum and black. The black coating is used to finish such large units as petroleum furnaces and exhaust stacks, while aluminum is used as a trim. Soon after the refinery went on stream, it became evident that

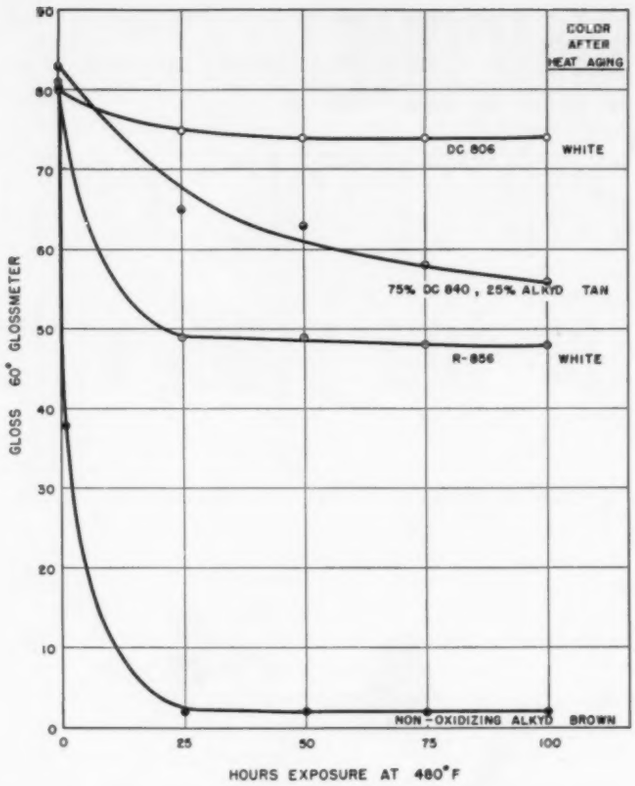

Figure 2 — Silicones have good gloss retention. Curves give gloss retention after heating at 480 F of silicone, silicone-alkyd, and alkyd white enamels.

even the best organic black finishes would not last from one annual unit shutdown to the next. Some areas developed rust stains within a few months. Finally, in July of 1952 when the steam boiler unit was down, its three 100-ft stacks were wire-brushed and refinished with a single coat of silicone-based black paint. The coating was allowed to air dry and cure when the unit was put back in service. Later, the petrochemical heater stacks and all the other stacks in the plant were refinished in the same manner. Today, the black finish is as bright and glossy as ever, despite surface tempera-

Figure 3 — Two coats of paint in a straight silicone vehicle withstood surface temperature of 400 to 600 F on these gas compressor exhaust mufflers for over three years.

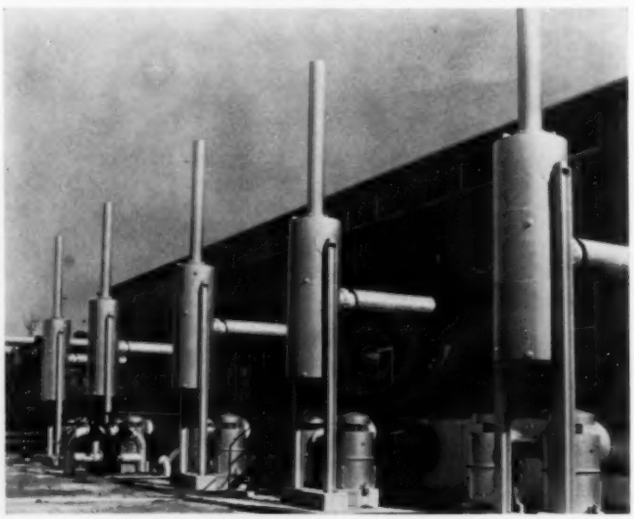

Figure 4 — These power house stacks, coated with a silicone-alkyd base finish, showed no signs of paint failure after four years of weather exposure. Temperatures varied from 100 F at the top of the stacks to 400 F at the base.

tures ranging from 350 to 700 F. Shutdown time has come and gone for all the stacks without repainting. As a result, the silicone paint has paid for itself in reduced annual maintenance costs.

MODIFIED SILICONE FINISHES

Modified silicone coatings are those finishes which contain both silicone and organic resins. In some cases, where heat resistance is important, small amounts of organic resin are added to give improved hardness and curing properties. In other formulations where extreme temperature conditions are not a problem, larger amounts of organic resins are used.

These coatings are important to industry as they fill the need for coatings with heat stability intermediate between that of organic paints and porcelain enamels. Modified silicone coatings provide finishes that approach the heat resistance of porcelain but are easier to apply and are less costly. The most common use of these finishes is on space heaters, incinerators, oven coatings and similar applications. The trend to light, natural finished furniture has created a demand for home heaters that complement such furniture. Other types are used on washing machines, bathtubs, etc., where water and soap resistance is important. With these new tools, the paint chemist can formulate many coatings heretofore impossible for use on industrial equipment and home appliances.

To meet the demand for light-colored heaters, Duo-Therm of Lansing, Michigan, offers a "platinum" finish. It is achieved by applying an off-white veiling over a light tan-colored, modified silicone coating. The platinum finish is more durable than any organic finish. It easily passes Duo-Therm's life test of 500 consecutive hours at a surface temperature of 450 F. Under the same test conditions, light colored high temperature coatings based on organic resins discolor, crack and flake. The modified silicone coating shows no deterioration.

To increase customer satisfaction, Duo-Therm also applies a modified silicone-aluminum coating to the heat chambers of most of their heaters. Able to withstand temperatures in the range of 600 to 900 F, this silicone finish eliminates the smoking of organic coated heat chambers when they are first fired in the user's home.

Another application is on home incinerators, a new and popular home appliance pioneered by the Calcinator Corporation of Bay City, Michigan. Early in 1952, Calcinator designers replaced the organic grey wrinkle finish on their standard model with a metallic brown modified silicone. The original units still look factory-fresh and are expected to retain their new appearance through many more years of service, even though combustion chamber temperatures occasionally reach 750 F. Calcinator's latest model is chrome-trimmed and finished in all-white. According to Calcinator, their silicone-based finishes have made these units the only incinerators on the market with Underwriter's Approval on the entire assembly.

Industrial ovens are also being finished with modified silicones. The new Grieve-Hendry cabinet drawer oven, especially adapted to preheating and stress relieving of small parts, has a heating range up to 850 F. It is so designed that any one of its 24 drawers may be opened without lowering the temperature of the remaining drawers. Each of the drawers is coated inside with a typical silicone containing aluminum coating. Grieve-Hendry has been applying this finish to the interiors of all their oil, gas and electrical ovens for over three years. Forming a smooth and uniform coating, the paint protects the metal surfaces against corrosion at surface temperatures up to 1000 F.

A similar finish, pigmented in black, is applied to the exhaust manifolds and crossover connection of all Lincoln and Mercury automobiles. Where conventional manifolds assume a burnt-brown appearance after some service, this silicone-containing finish stays black and glossy for years. First used on the manifolds of the 1953 Lincoln, the silicone finish is designed to last the life of the automobile. No noticeable deterioration has been observed after as many as 100,000 miles.

Other applications include ordnance heaters, oven thermometers, outdoor broilers, radiant heating panels, etc. All make use of the heat resistant properties of silicones.

SILICONE-ALKYD COATINGS

Another group of modified silicone coatings attracting increased attention is the air drying, general maintenance type coatings. These coatings are based on blends of special silicone resins and air drying organic resins, or on copolymers of silicones with alkyd or other organic resins.

The important properties of these coatings are their

long weathering life and improved color retention. The silicone-alkyd copolymers exhibited the most promise in the early development work and have been evaluated more than other modifications. These copolymer resins have excellent weathering properties and have shown good heat-resistant properties to 500 F. Low silicone types darken upon exposure to high temperatures, but have excellent adhesion and can be used in dark colors. If light colors are required, the silicone content must be increased in proportion to the temperature.

The air-drying properties of these silicone-alkyds combined with heat resistance make them particularly useful as plant maintenance coatings. Four years ago, a grey silicone-alkyd coating was applied to the powerhouse stacks in our plant. Today, these stacks are still in excellent condition. The temperature at the base of the stack is 450 F. All previous coatings failed because of peeling and rusting in the lower areas of the stacks. The silicone-alkyd coating has given excellent protection over the entire surface of these stacks, indicating their usefulness at both high and low temperatures.

Another example where these silicone-alkyd coatings can be used economically is on surfaces that are costly to paint, such as water towers, distillation towers and similar equipment. The use of silicone-alkyd-coatings on such equipment will give good protection and maintain a newly painted appearance for years instead of months. The chemical resistance of silicone-alkyds is similar to alkyd resins. Thus, they should not be used in severe chemical atmospheres. The coatings have excellent adhesion to metals and can be applied over organic primers. The improved color retention and good weathering properties of these silicone-alkyd coatings make them of special interest as plant maintenance finishes.

These new copolymer resins, along with the straight and modified silicone coatings, make possible a number of new uses for protective coatings. If heat, weather or moisture resistance is a problem, then silicone-based coatings should be tested. Continued research is in progress to develop even better resins for use by the iron and steel industry. New combinations containing silicone with phenolic and epoxy resins are expected to have improved chemical resistance and good weathering properties.

After ten years of use, silicones have proved their merit in many protective coatings. Future coatings should help in the fight against corrosion and produce better, more durable products.

DISCUSSION

PRESENTED BY

RUBERT CAPLEY, Chief Engineer, Steel & Tube Div., Timken Roller Bearing Co., Canton, Ohio

R. C. HEDLUND, Supervisor, Coatings Laboratory, Product Development Laboratories, Dow Corning Corp., Midland, Mich.

Rubert Capley: In ordinary maintenance such as stack paints and also roof coatings, I am wondering if there is a possibility of decided improvement in these paints through the addition of silicone. Such claims are made by people who are probably less experienced in the use of silicones as compared with the people who developed it. Also on masonry waterproofing, we have applied silicone and found that as time goes on, it appears to lose the effect of repelling water. In other words, if you pour water on the wall a few days after the silicone is applied, it will all fly off in droplets, but after six months or a year you are not sure whether it is being repelled or not. Does it lose its life after a certain length of time?

R. C. Hedlund: Our experience and the experience of a number of paint manufacturers has shown that the addition of silicone resin will improve the corrosion resistance at high temperature of aluminum paints. There are a wide variety of silicone paints available. Some contain 100 per cent silicone resin and others may contain 10 per cent silicone. I think if there has been difficulty with corrosion resistance in these paints, it may be due to the silicone content in the formulation.

I would suggest that you obtain materials from various suppliers and evaluate them in your plant.

The second question was on masonry water repellents. I did not cover these products in my paper but they are one of the major uses of silicone resin. What Mr. Capley stated is true, silicone water-repellents are very spectacular in their initial appearance, and after about a year's exposure they will lose this highly water-repellent surface. However, they do not lose their water repellent and low water absorption properties. We have seen buildings that have been coated for five years and after five years' exposure they are giving excellent protection to water leakage, but the surface of those walls will wet with water. One thing that can be done to check the presence of silicone is to take a wire brush and brush the surface. In most cases you will find that underneath the dirt and grime collected on the wall, the silicone is still there and the under surface is water repellent. Thus, silicones will lose their surface repellency in about a year, but they will not lose the ability to prevent water from soaking into the wall.

AISE WESTERN MEETING

February 24, 25, 26, 1958

Hotel Statler **Los Angeles, Calif.**

. . . . when a mill is first installed or revamped there is still much to be done before the final operating layout and procedure are established . . . the following paper covers changes and improvements on the part of the operator which increased production and obtained smoother operation of a revamped plate mill. . . .

Revaluation of the 84-In. Plate Mill Modernized at Alan Wood

By FRANK J. BAMPTON

Superintendent, Blooming Mill and Plate Mills, Alan Wood Steel Co., Conshohocken, Pa.

▲ IT is now two years since the modernization of the 84-in. plate mill at Alan Wood Steel Co. was completed. Therefore, it is fitting that the planning should be reviewed and compared with current operations in an effort to evaluate the expenditure of approximately $3,000,000. Figure 1 shows the layout as proposed. In this review, each operation will be discussed in order from the slab Yard to final shipment and the more salient points of modification found expedient in the process of getting the new units into full scale production will be emphasized.

The remodeled slab handling crane with its new girder, cab and tongs has been found to be quite adequate in safe handling of slabs in group form while also being comparatively free of maintenance. The addition of a 7½-ton gantry crane and a 30 x 100-ft scarfing bed has provided space to condition approximately 35 per cent of all plate mill slabs on a single shift basis. With the quality of the slabs received from the blooming mill at its present quality level, this percentage of scarfing is adequate.

The depiler crane and slab conveyor have only slight variations from the original design. The position of the cable reel has been changed to lessen the possibility of cutting the power cable, and has definitely proved advantageous in minimizing delays encountered in this regard. One pallet strand has been removed from the five-strand furnace charging conveyer since four strands are found to be ample for supporting the longest slabs which are in the range of 78-in. maximum. There was a problem with the scale being deposited around both the supporting and return pallet rollers which could have proved to be quite costly from a maintenance standpoint. This was relieved by cutting sections out of the base of the supporting roller channels and installing a sloping plate cover over the return pallet rollers, thereby allowing the scale to be directed down into a trench from which it could be readily removed. In addition, a steam jet assembly has been installed to blow scale from the top of the slabs rather than have the depiler operator sweep them off as originally planned. This scale removal operation is performed by the depiler operator without the need for his vacating his control pulpit at any time during normal operation. At the discharge end of this conveyer, a simple finger limit stop between the second and third strand was installed rather than the cumbersome bumper stop originally designed. A simple screw and nut with a crank arm moves the stop to center the slab for charging.

At the furnace proper several very beneficial changes were made. As originally installed, the unloader boom became overheated due to flame impingement in the No. 5 or soak zone, and had a tendency to warp out of shape.

After several boom renewals a trial run was conducted with one radial burner cut off on the inside face of this zone. On the basis of the results obtained from this test run, it was decided to eliminate this radial burner, change the tangential outside burner to radial, and install a baffle wall, the bottom of which was to be 14 in. above hearth elevation and the top a laced effect to permit the passing of gases (Figure 2). This was done and a new boom installed June 9, 1955, which is still in service at the present time.

The oil hydraulic tanks and pumps for actuating the loader and unloader booms were originally installed on a grating type platform located above the operator's station and between the two booms. These units have since been moved to floor level at a point just outside of the charging boom. This move has aided materially in keeping the proper maintenance on these units, primarily due to the more solid mounting which materially lessens the vibration problems noted at the prior location. The furnace hearth was installed with rows of 3-in. raised brick which formed a trough for the passage of gases to the bottom of the slab. However, slag falloff during the heating cycle rapidly filled the trough and in effect there was a solid hearth within a relatively short period of operation. After renewing the hearth once, it has been decided it is more advantageous and economical to operate with a solid hearth at all times and use eight hours each week-end to clean out the high spots or bring the hearth to proper elevation by the addition of furnace scale.

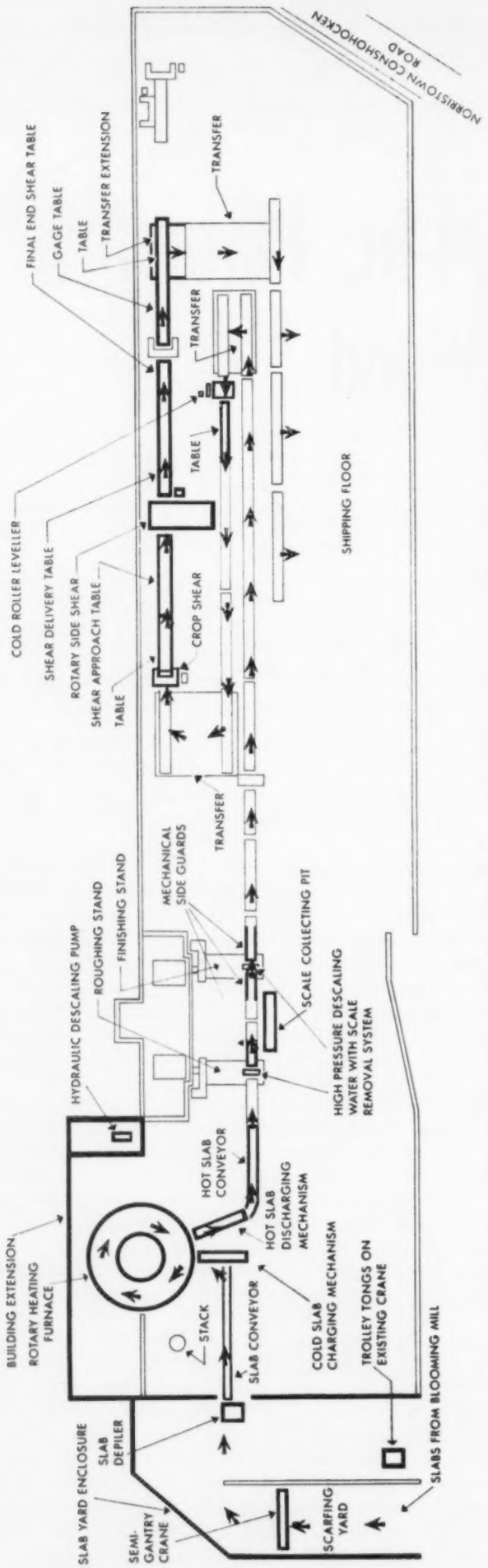

Figure 1 — Layout shows product flow through 84-in. plate mill. Heavy lines indicate new or relocated equipment.

The roof as installed was of the suspended brick type and although probably adequate under ordinary usage seemed to require excessive maintenance as tonnage heating requirements increased. Therefore a one hundred and fifty degree area in number three and four zones with a castable ceramic material was installed which is very satisfactory in meeting the higher furnace temperatures and pressures employed at the present time. In fact, an additional segment will probably be installed as soon as convenient.

The use of this type of ceramic material has given twofold benefits: much less spalloff during the week-end shutdown and lightup necessitated by the hearth leveling program, and increased heat retention during actual furnace operation.

The burner arrangement as installed provides for either oil or gas. Although gas would probably be more economical, since it is not available, oil is used exclusively. The air volume in No. 2 zone has proved to be inadequate for the amount of oil that can be utilized in No. 2 zone. We are therefore engaged in obtaining a blower of increased size to remedy this condition and derive the heating benefits available thereby in this zone. The fuel, steam and air valves as originally installed were located in manifold arrangement in the center of the furnace proper at the lowest elevation and as experience indicated in a very inconvenient location from the standpoint of accessibility to adjust or service. They have since been moved to the hallway area directly under the hearth proper providing a much more accessible location for proper maintenance.

Furnace performance is rapidly approaching the expected projection. Oil consumption is close to 16 gal per ton. We have attained 89 pieces in one hour, 561 in eight hours as compared to a maximum of 75 per hour in the planning. The heating rate based on 25 minutes per in. of thickness predicted 40 tons of slabs heated per hour or 32 tons of product per hour at 80 per cent yield. We have drawn 79 tons in one hour and 435 tons in eight hours for 350 tons of product at 80.5 per cent yield. On this record turn the average slab was 4 x 28 x 65 in. at 2041 lb, and total delay time was 13.5 per cent. So far this year we have averaged 25 tons per hour of product which compares favorably with the rate under the former setup which used considerably more manpower, 6.5 gal more fuel oil per ton, six side door furnaces, more furnace maintenance and a 15 per cent heavier product mix. It has been determined that for a fixed yield and delay figure the controlling factor in heating with this rotary furnace is average slab weight, therefore the one item that will do most to improve furnace heating time is to minimize slab thickness.

This factor was recognized in the discussion with the furnace designers; however, in actual operation it is very difficult, in fact almost impossible, to increase and decrease slab thickness according to their theory which would provide the greatest efficiency of furnace operation, but unfortunately does not meet other qualified contingencies such as customer shipping commitment dates, etc. We are therefore endeavoring to use the maximum width, which is now 30 in., with a minimum thickness and length to accomplish the maximum number of pieces which can be charged into the furnace commensurate with good heating and operating prac-

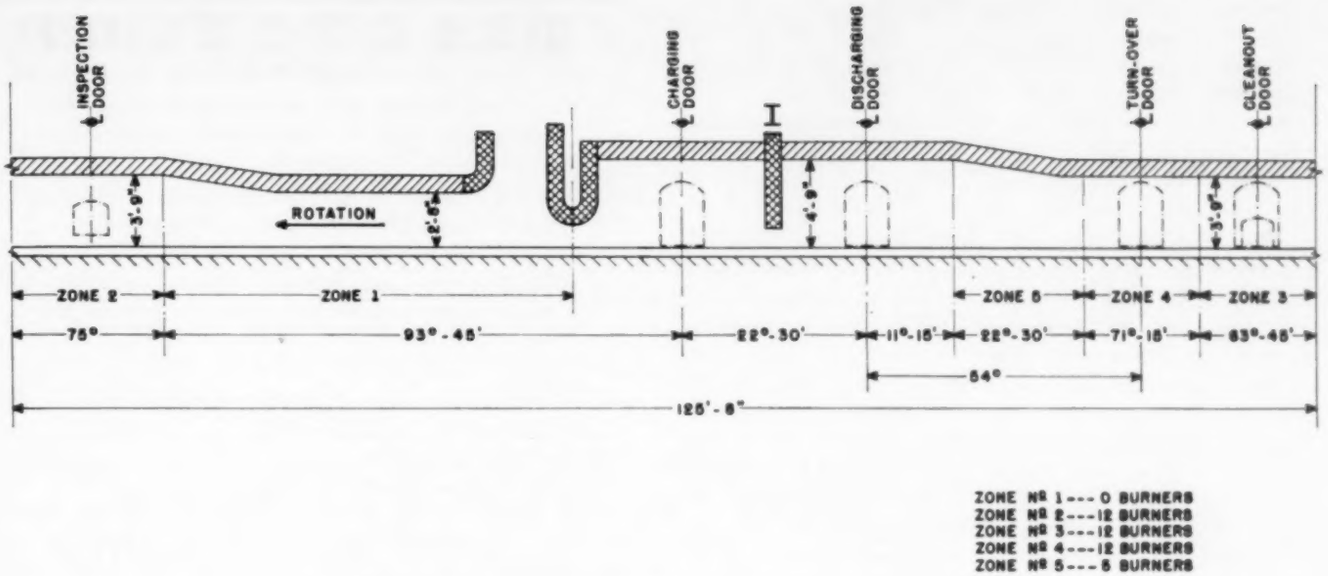

Figure 2—Sketch shows extended view of plate heating furnace.

tice. This has caused our slab source to alter ingot sizes for better slab provision.

Before leaving the furnace, it would be well to state that hearth maintenance at the proper elevation is of utmost importance. The booms have a maximum upward adjustment of 1¾ in. and a high bottom not only causes mechanical and electrical failures in boom operation, but more seriously causes slag fillup in the water seal. We have recently cut an extra cleanout door in the number one zone to aid in the week-end cleaning of the bottom and are developing mechanical equipment to aid in the movement of the slag from the furnace to the dump truck in order to lessen the existing labor man-hour requirements.

The curved delivery table from the furnace has not caused much delay; however, the maintenance of the gear motor units has been excessive due to inadequate sealing of the gear oil which leaks through into the insulation of the bottom mounted drive motor causing excessive maintenance. We are therefore now considering horizontal gear motors as a replacement for these vertical units as installed. The descaling system has done a creditable job with the exception of one or two valves which require excessive repairs. Here few changes from the original plan for the delivery of water at 1200 psi at the nozzle have been required. We do find it difficult to maintain the most advantageous nozzle to plate distance on a three high mill in order to realize the maximum impinging force.

The automatic side guards and movable guard at the hot leveler approach table were in operation before the modernization and are satisfactory when considered in the light of manpower saving and product quality control. It has been an established fact that the existing lift tables being of very light construction and of limited lifting power would pose an engineering problem when the design was changed to accommodate automatic side guards. Due to the stringent weight limitations involved, it was not possible to install automatic side-guards sturdy enough to do the job with a minimum of maintenance. The maintenance on these automatic side guards and tables has therefore been fairly high. It is our intention to develop a heavier type lift table to better meet these operating requirements as time permits.

The cold leveler although limited as to thickness of product has greatly improved the flatness of our final product. We suffered the usual interruptions and breakages due to inexperienced operators during the early training stages, but present operations have now greatly minimized the number of releveled plates. However, it must be stated that a leveler of greater thickness capacity would have been more acceptable.

The layout line was shortened due to the installation of the cold leveler but is still adequate for product flow. The remodeled hydraulic or first crop shear in the shear line has been altered from the original design to what is felt to be a more practical operation. We also found that the operation required a scrap-man to keep the line moving in the most expeditious manner and have provided the same. The hydraulic holddown and oil-gear actuating cylinder caused too much maintenance for the benefits resulting. They have been eliminated. The crop chute and box arrangement leaves much to be desired, but space limitations do not afford a better plan except to possibly use a bottom opening box which would enable us to load scrap in a more suitable manner for open hearth charging.

The rotary shear is performing as predicted, although many hours were spent perfecting the crew, learning to properly adjust the knives and chopper speeds, and improve the scrap chute. Perhaps the biggest improvement over the original installation is the oval shaped stainless steel scrap chute. The 60-in. knives use one edge per week and are carefully alined every two weeks. The 15-in. top knives are changed as required by product, changes being made generally during roll changes or mill delay time. The remodeled hydraulic or final end shear has performed almost as planned except that here, as at the crop shear, we added a scrap man to facilitate the product flow with a minimum of delay time. The skew table and pushers in front of this shear do an effective job in keeping the plate against the straight edge, the hydraulic holddown is satisfactory.

The chain conveyor covering the space between the first table roller and the knife edge has been replaced by a series of chain driven rollers which has greatly minimized the maintenance of this unit. The actuating cylinder for the tilt table, as on the first crop shear, has been removed since keeping balanced pressure in the planned closed system caused excessive maintenance for the results obtained.

The shear gage table with skew disc rollers has been a good installation. Building up of the skew rollers by welding and filling in the worn slot in the straight edge are not considered serious defects. As originally planned, the location of this shear operator's pulpit required that some system be installed to indicate the position of the gage stop since he could not see the gage from his operating position. Originally a synchronized lock unit with two torque motors transmitted this indication to a clock in the pulpit which indicated feet and inches. This proved entirely unsatisfactory for this installation. This unit has been replaced by two selsyn units, a transmitter from the gage stop and a receiver for the meter which records accurately the feet and inches between the shear blade and the gage stop. This has proved very satisfactory.

The chain conveyor table and new table rollers from the final end shear to the shipping floor have caused little difficulty and, except for the clutch designed for using half of the chain, operates as planned.

In the resquare area, there is one 192-in. hydraulic and one 112-in. electric shear as installed. Here not much was planned during the original engineering design except general unit location. The final use of this area and equipment has been put into the hands of operations and justly so. We have such a variety of shearing, test cutting, grip shearing, blasting and painting that only experience would prove the best arrangement. In this area, we stock grip, excess plate and plate ends so that we may cut to requirements on short notice or split or resquare special items. The only item not originally planned for that has been added in this area, is a hood with an exhauster fan for use when painting or sandblasting grip plate. On the shipping floor no changes were planned but we have since erected a new office outside of the operating building and rearranged the floor to give maximum operating space since this area is not quite adequate for our variety of orders.

SUMMARY

The installation, as a whole, is adequate when considering the fact that all the flow diagram changes were accomplished within the confines of the existing building. The units, mechanical and electrical as planned and installed are performing as predicted. The heating unit, while on the small side for some slab sections, is adequate for the product mix as seen during these two years. The saving in manpower and fuel have been realized. The estimate in yield increase remains to be achieved for currently we are averaging 79 per cent although we have had as high as 83 per cent. The product tons per hour is comparable with former record years and will be greater as the product mix approaches or passes that used in those years. Finally, management and engineering deserve much credit for a job very well planned and executed.

DISCUSSION

PRESENTED BY

E. C. PETERSON, Vice President, Rolling Mill Equipment Div., Birdsboro Steel Foundry and Machine Co., Birdsboro, Pa.

FRANK J. BAMPTON, Superintendent of Blooming Mill and Plate Mills, Alan Wood Steel Co., Conshohocken, Pa.

W. B. CARTER, General Superintendent of Maintenance, Alan Wood Steel Co., Conshohocken, Pa.

E. C. Peterson: There often is much publicity at the time a job goes in, and then nothing more is heard of it, and actually some of the most interesting things about a new installation do not develop for years.

The author mentioned the problem of thickness limitations on the leveler; this is a constant problem in leveling applications, because it is so hard to make a leveler that will adequately level a wide range of products.

In that connection I would like to ask the author what range of plates they undertake to level, and where they run into trouble.

I would also like to ask him what spacing of rollers they have on their machine, since the spacing usually determines the range of thickness that can be handled.

Another problem of interest in connection with leveling installations is that of top adjustable rollers vs bottom adjustable rollers. We have felt that top adjustment makes a good installation because it maintains the pass line of the machine more nearly on the table level. I believe that the machine at Alan Wood has a bottom adjustable nest, and I would like to ask the author how he feels about the construction, and whether he thinks there is any advantage to having top adjusted rollers. I would like to ask him also whether he believes that a nest of rollers, adjustable only at each end, is flexible enough and as satisfactory as individually adjusted rollers?

Referring however to the particular shear gage application that the author mentioned, we furnished this unit with a synchro-lock driving a dial indicator. This unit developed unexpected difficulties, and Alan Wood replaced it with a small selsyn set driving a mechanical control. For remote control of a gage, this arrangement is hard to better for simplicity and effectiveness.

Frank J. Bampton: We worked very closely with the manufacturer and Mr. Peterson on this problem. It was pretty much of a rush at the end. We told them we had to have the tables August 1. We insisted on this date and they did it, and did a very good job. There is a lot of good engineering in the design.

The limitations on the leveler are $\frac{3}{16}$ to $\frac{9}{16}$ in. I would like to have had it at $\frac{3}{4}$ in. because that is the limitation on the shear. As far as putting the big one in, you could not get it in without moving the building. It would not have left an alleyway for passage.

As far as the nesting, I like it, rather than individual rollers. As to the adjustment on the bottom, I do not see any difference, bottom or top.

W. B. Carter. The rollers are about $5\frac{1}{2}$ in. They are on about $6\frac{1}{2}$ in. to 7 in. centers, and the worst problem we have had with levelers is twisting off the spindles primarily in the early training of the operators.

COORDINATION Between Engineering and Other Departments

. . . . only when engineering effort is fully coordinated with the work and potential of all other departments is the engineering department of most value to the company it serves .

By
J. WILLIAM DePOY
Chief Engineer
Pacific Coast Div.,
The Colorado Fuel and Iron Corp.
Oakland, Calif.

▲ THE day of the "attic inventor" and "lone genius" engineer is ended. Although part of an era that has passed on to us a rich heritage of technical facts, its methods and organization are obsolete.

Today, the engineer finds himself in the midst of a highly organized, technical based society. The developments of the past century have produced a wealth of technical detail which has been accepted by the community at large as a normal part of their lives. In modern industry, the engineer must not only be technically competent, he must be able to co-ordinate his efforts with those of other technical men and of a host of non-technical individuals and groups.

It is this co-ordination of engineering effort with the activities and needs of other departments that presents to the engineer one of his most challenging problems today. It is a problem that is sometimes discouraging, and frequently frustrating. At times it seems a complete waste of time and effort. Experience has shown that properly handled and adequately exploited it can become a vast source of information and inspiration.

Skillfully developed, this co-ordination brings about results that can be obtained in no other way. When the technical skill of engineering is combined with the commercial merchandising skill of sales, the resulting product may well be outstanding in basic function, durability and initial sales appeal. Co-ordination with other departments will likewise reflect in superior solutions to the complex problems of modern industry. Certain problems will lend themselves to solution within the engineering department by equation and slide rule. These purely engineering problems may require the assistance of specialists or experts within the technical fields. Such experts may be members of the department, outside consultants, sales or application engineers, or other technically skilled persons. It is assumed that the department head is competent to co-ordinate the efforts of these technical experts. He should not have any considerable difficulty obtaining the answers to this class of problem.

He must also have the ability to recognize what problems fall into this "pure technical" class and what problems do not and he must be capable of defending his technical results.

It is, however, in the very large class of problems which do not have a purely technical solution that this article will discuss. Many, if not most of the projects that must be handled will require co-ordination with one or more other departments.

Sales, production, accounting, management, maintenance, industrial engineering, purchasing, customers, supplier, even public utilities may be among those affected. Good modern engineering must co-ordinate all of these diverse viewpoints, plus the limitations im-

posed by the laws of nature, and obtain a result that will be optimum.

This will not always be easy. A broad range of personality and interests is involved. The difference in viewpoint between sales and production on a product that is easy to sell but hard to produce may sometimes create considerable friction. If the divergence of opinion is further spread by an extrovert personality at the head of one department and an introvert in charge of the other, the co-ordinator may well wish co-ordination had never been heard of.

Consider the solution that will satisfy both of these diverse viewpoints and needs. It may be difficult to obtain. The patience of all concerned may be fully tried in the process. Once obtained and put into effect however, it will prove well worth the efforts expended. One or two such results will do wonders toward improving future co-ordination.

A number of the projects of The Pacific Coast division of The Colorado Fuel and Iron Corp. have been examples of this co-ordinated effort. The diverse needs and viewpoints of all departments concerned have been fairly represented and adequately considered. There has been no sacrifice of the basic technical accuracy which is the responsibility of engineering. Neither has there been a compromising of the basic needs of other departments. The ultimate result has been projects that worked to the satisfaction of all concerned.

Unless the engineer recognizes this need for interdepartmental co-ordination his work will fail to be fully adequate. The modern engineer may no more expect to find the solution to all his problems within his own department, then he may expect to find the origin of his projects therein.

The project may originate in the sales department and may come about from one of a number of causes, or from a combination of several of them. A market survey may develop the need to go into a product not heretofore made. This may be an entirely new product not now on the market. It may be a product now produced by a competitor, or an improvement thereon. Customer demand may require the improvement of an old product to meet the customer's needs. Competition may necessitate the modification of an old product to meet demands of price, quality or appearance.

Any of these causes, or a combination of them may cause the sales department to express a need that will develop into an engineering project. Here the source of the project may have little or no concept of the technical problems involved, the cost of the project, nor its total complexity. The sales department knows that customers are being lost, and that engineers are supposed to solve problems.

The project may originate in production or maintenance as a result of inadequate capacity, obsolete equipment, excessive costs, safety problems, or repair difficulties. Here more comprehension of the technical problem may be expected, but must not be taken for granted. A proposed change may violate the basic law of leverage, or may destroy the sales appeal of a product.

Many other sources of origin might be listed or enlarged upon. Some might be general to all industries. Some are special to the steel industry. Some are specific to a single plant or corporation. The manner of stating the problem, the data presented, the solution requested will vary in nature and completeness with the source. All will have in common the need to be clarified, expanded, co-ordinated and solved.

The project may start with so simple a need as a light on the watchman's path. It may end with a sixty watt light fixture. It has been known to develop into the floodlighting of an entire building for advertising effect, when all concerned were brought into the picture.

At the other extreme we have the complex project that will require the development of a complete new plant. This plant will produce a product that is yet to be designed. This product will require materials that must first be perfected by research. Sales and advertising must develop the market for the product. The television industry of a few years ago may be cited as an example of this type of project in its perhaps most extreme phase.

Fortunately most of our projects fall reasonably between these two extremes.

The information available at the start of the project may likewise vary from a complete specification to the vague "something that the customer can use to solve his problem." Where the complete specification is available, the project may entail only a technical solution. At the other extreme, considerable preliminary detail work may be required to even determine adequately what the "customer's problem" actually is. Fortunately, again, most of the problems encountered fall somewhere between these extremes. Frequently the originator of the project is a non-technical man who has little concept of the type of information necessary to engineering. In many such cases good co-ordination requires only that the originator and the project engineer be brought together to discuss the problem.

It may be necessary to call upon several departments for relevant data and to assemble it into a comprehensive whole. This may then require review and reanalysis.

It is at this stage that the general conference of all concerned can be of considerable value. Properly led this conference can co-ordinate the thinking of all concerned, and develop much factual information.

Selection of the proper persons to attend such a conference, and briefing them on the problem to be considered will contribute considerably to the success of the meeting. Pertinent data and information may be obtained in advance of the meeting. Departmental subordinates or superiors may be consulted beforehand. Necessary preliminary groundwork should be done by each person before entering the meeting.

The group leader must keep in mind the basic objective of the preliminary general conference, "What is the desired final result." Under certain conditions he may be justified in permitting the group to turn its attention to a second objective, "How can this result be obtained."

If the first of these objectives can be attained by the general conference, so that all concerned are properly aware of what is to be developed, the meeting may be termed a success. The development of detailed means to achieve the result is sometimes better left to smaller

groups, often technical and operating men. It is frequently desirable to interrupt this first conference for a period of hours or days to gather further information or permit sub-groups to discuss details that are not of interest to the larger group. This interruption should not be longer than necessary. It should not unduly delay progress. Neither should the leader permit the group to evade responsibility by the generality of deferring a decision till "next meeting," when there is no reason to believe that additional data will be developed by the delay.

The development of this clear understanding of the objective of the project in its early and formative stage will prevent much misunderstanding later. It will also lighten the load on engineering. Much engineering time and talent can be wasted on a problem, when misdirected toward a goal that is not the true objective of the project. Nothing can be more disconcerting than to come up with the right answer only to find that one has started out with the wrong question.

A word of caution is perhaps in order here. These preliminaries can easily drag out over many months and delay a project out of all reason. If the project must be held up awaiting information from one source, it should be examined to see if there are other missing factors that can be obtained simultaneously. A major project should not be delayed awaiting information on a minor point or a nonessential detail. These preliminary conferences and investigations must be used to expedite the project and not to delay it. Unless they result in a faster and better solution of the project problems, they are not achieving their purpose.

Once the preliminary conference has established a definite understanding of the final results desired, the project enters the second, or detailed design, stage.

Much of the detailed design work will be of the strictly engineering nature that will lend itself to slide rule and drawing board. The assumption of departmental competence is again valid as respects this type of problem.

There will however, be detail problems not of the strictly engineering nature, and problems arising out of modifications of the pre-determined result because of the engineering studies.

Here again there is need for co-ordination and cooperation to steer the project through the needs and changes of the design phase. Individual or small group discussions are generally more suitable than the more general type of meeting used in the preliminary stage of the project. These may be with department heads or their immediate subordinates as may be necessary. Individuals or groups of suitable experience and talent may be drawn from whatever rank or level may be desirable to obtain the required result.

The value of these small groups in the pooling of information and experience should not be overlooked. This is particularly true of new development work where past experience must be extrapolated considerably. When the project does not seem to be progressing at a suitable speed toward a satisfactory result, the calling together of a small group of interested individuals to discuss the problem with the project engineer may result in a new or varied approach that will expedite the solution.

At the Pacific Coast division of The Colorado Fuel and Iron Corp., it has been found advantageous to keep this phase highly informal. Perhaps size has helped, as most of the personnel are well known to those in other departments. The way having been paved in the preliminary conference session, it is possible for the design engineer to work directly with the salesman, master mechanic, production foreman, machine operator, or day laborer who may have something to contribute to the problem. Proper channels should be followed in making these contacts, particularly as the lower ranks are approached. The channel should be for approach, however, and not for the transmission of information. Talking with a man's foreman or superintendent is a poor substitute for talking to the man himself.

The opinion of a machine operator as to the convenient location of a control, or his experience with a given material is of real value. Care must be used to filter fact from prejudice, but the man on the job is a valuable source of data.

Ideas from these sources must be treated with care. They may be poorly expressed and inadequately thought out. They may require much work to bring them into condition to use. But they are frequently sound and based on years of experience. The man may only know that some device is not as it ought to be, and have no idea of how it should be. He may even be resentful because he feels the "boss" should know these things without being told. Such resentment must, of course, be overcome by removing basic misunderstanding or distrust. Used as a source of data rather than as a solution, his contribution is of great merit and value, and he should know that he has received proper recognition.

It might not be out of place to comment briefly on the nature and psychology of man. The man who has been consulted on a project will go all out to make that project a success. This alone might well justify any time spent with him. While his own idea may have been rejected in the final solution, if he feels that it has had due consideration he will be pleased. If the reason for use of a different idea has been clearly and properly shown to him, his interest in the project will still be personal. This interest and desire to make it work is a valuable asset in any project.

Considerable expansion of the available data may be necessary, and the responsible engineer must expedite the acquisition of needed facts. Customers may be contacted through the sales department. Where necessary, direct contact may be arranged between the designer and the product user. If an adequate understanding has been developed between the sales department and engineering, this portion of the task presents no problems. Such an understanding should be clearly developed before the customer is brought into the picture. Under no circumstances should engineering attempt direct contact with the customer without the assistance and cooperation of the sales department.

Much individual latitude exists here as to whether the project engineer should enter directly into discussions with the customer or whether information should be channeled through the sales department. Circumstances and conditions may enter into this problem which must

be considered. Individual abilities and personality of sales man, engineer, and customer must be considered. No hard and fast rules should be established while this is being done, engineering may be working with the purchasing department to develop information from suppliers of equipment and material. The price, availability, physical characteristics and appearance of a first choice and several alternates may need investigation. Here again good co-ordination may save large sums of money.

Experimental work may be necessary to develop the ideas. Engineering, production, and maintenance personnel may co-operate in this work, as well as laboratory and research groups. These must be guided and co-ordinated in such a manner that their individual contributions may be used to the best advantage. Care must be taken that valuable effort is not expended on side track or dead end experiments, and that the project is not unduly delayed awating experimental results.

With the basic data gathered and a tentative design developed, engineering must again approach those concerned to determine whether the design meets their concept of the project. This may be by individual discussion or by group conference as may be dictated by the nature of the project.

A final design must then be developed and submitted for approval to those concerned. In the case of a complex project, the portions submitted to various department heads may vary considerably. The head of the sales department may quite justifiably have much more interest in the final product and its attractive package than in the ease of servicing a clutch or cutter blade. The master mechanic may feel that the package as such is a nuisance, but that automatic greasing is a god-send.

These diverse points of view having been co-ordinated the final and accepted design is ready for submittal to management for a final decision.

It will be seen that if the co-ordination efforts outlined above have been properly executed, the responsible department or division heads will be familiar with the project in much detail. Confidence and proper liaison exists, and management may be sure that the project has been given due consideration at all levels and represents the best co-operative effort of the entire organization.

The formal submittal constitutes a final review of the project for practicability, equipment and materials, production problems, sales problems, accounting and finance problems, probability of adequate return.

It is rare indeed that a project developed by this co-operative effort and subjected to this critical review does not succeed.

With the approval of the project the planning stages of the project are completed. Engineering is then ready to enter upon the construction and installation phase. Again it may be assumed that the preparation of detailed plans and specifications, purchase requisitions, work orders and other paper work require only reasonable technical competence and will proceed in a workman-like manner.

Co-ordination of the project schedule with production schedules to avoid conflict is essential. Purchasing department, receiving department and outside suppliers must be co-ordinated with the over-all progress of the project. Co-operation between outside contractors and plant maintenance or installation personnel must be assured.

The co-ordination set up between project schedule and plant production schedule must be followed through into the operating departments concerned and established as a reality. So simple a thing as a water line to be laid across a busy plant street or aisle-way may call for the co-ordination of three or four departments and one or two outside contractors. Co-operation of customers in receiving shipments on an advanced or delayed schedule may bring sales back into the picture.

Plant protection may be rightly concerned if an external wall is to be removed or a sprinkler pipe water supply interrupted. Accounting may be involved in the abandonment or salvage of old equipment.

These are some of the problems that must be co-ordinated during the construction phases of the project.

When construction and installation are completed and test and acceptance runs have been made, the equipment will be turned over to the operating department. Engineering must render proper assistance in this phase to adequately instruct personnel in the operation and maintenance of the equipment. Services of manufacturer's representatives of special experts may be needed. Co-ordination still remains the basic theme.

Throughout the entire project, from original concept to final shipment of the finished product, the personnel of the engineering department must continually bear in mind that their basic function is to insure the production of the best possible product in the optimum manner. No source is too insignificant, and no idea too small to be of value. Superiority must be a function of the product and not of its designer. It is the function of engineering to screen every possible source and develop every possible factor of idea, material, and equipment that may improve the product or its production. This function is easy to bury in the overwhelming mass of technical detail that faces the engineer. It cannot be so buried if a successful project is to be developed. Nor may the mass of technical detail be overlooked. This detail is indeed engineering's own contribution to the project, and the successful project is the one that will face the combined test of slide rule, balance sheet, and sales report. The properly co-ordinated, well integrated project will pass this triple test.

The successful engineering project under modern day conditions requires much more than the bringing together of highly skilled technical personnel to solve complex physical and mathematical problems. Co-ordination with the needs and viewpoints of non-technical departments of the organization is of great importance. Consideration of the requirements of maintenance and of production is a necessity. Supply and procurement must receive due consideration. Ideas must be sought out, brought out, and developed for what they are worth. Full use must be made of technical development and research facilities available.

It is only when the engineering effort is fully co-ordinated with the work and abilities of all other departments that the engineering department can be of the most value to the corporation it serves.

DISCUSSION

PRESENTED BY

SAM RUVKUN, Executive Engineer, Kaiser Engineers, Div. of Henry J. Kaiser Co., Oakland, Calif.

Sam Ruvkun: Mr. DePoy has reviewed the problem faced by engineers in trying to co-ordinate the efforts of people with various backgrounds to weld their specific knowledges into one understandable report to arrive at a definite conclusion. He has set our minds to thinking of our own co-ordinating efforts to determine whether we are doing all that we can do.

Quite similar to Mr. DePoy's experiences with a steel company's manufacturing operations are the experiences we are having on our assignment for the Tata Iron and Steel Company's $130,000,000 expansion in India. The engineering on this project requires special co-ordination. We have 2500 original design drawings to prepare of which some are being prepared in India and the majority are being prepared across the Bay in our design offices in Oakland. The co-ordination that we engineers must achieve is the efficient flow of information between the two design offices located 10,000 miles apart and the tying in of information made available by equipment suppliers from nine countries on three different continents. We achieve this co-ordination by a basic understanding of areas of responsibility, supplemented by communication links including cables, letters, engineering drawings, pictures and visitations.

Mr. DePoy rightly states that the engineer is most valuable to his corporation when his efforts are properly co-ordinated with other departments. It is the engineer who is the co-ordinator in expansion proposals and research projects. The question might rightfully be asked, "Why is the engineer the one to do the co-ordination?" I suggest we examine the definition of an engineer. I am not satisfied with the classical definitions of an engineer so I have concocted my own. It is simply stated as follows: "An engineer is a person who portrays scientific or technical facts today for actions which are to occur tomorrow." This description does not mean that the engineer is a "crystal ball" gazer. It means that he foretells the future based upon detailed analyses of past occurrences. His technique is to: (1) spread out and analyze the information in a manner such that each individual phase of a problem can be properly understood, (2) discriminate between the important and unimportant facts, (3) weld such information back together to solve the problem. This requires co-ordination or team effort of a number of people.

In effect the engineer is a co-ordinator. Having been such a co-ordinator for many years, I can define the co-ordinator further. He is a busybody. Everything on a project is his business. If he is to accomplish the purpose for which his co-ordinating efforts were set up, he must have a working knowledge of, and be able to pull together, facts from different departments including the accounting and finance people, lawyers, purchasing agents, design engineers, consultants, estimators, construction and production people and suppliers of machinery and equipment.

The dictionary defines co-ordination as "the act or state of working together and functioning in harmony." Sometimes the only way to get harmony is to knock a few heads together, but at least the end results of co-ordination will appear to be harmony.

Typical of the value of the engineer to a corporation was a recent assignment covered in the South for a building materials firm. We were requested to investigate all departments of this firm which had just changed ownership and to determine the business potential of the firm. Detailed investigations required numerous interviews with everyone of the operating departments of the firm and, to be sure, the co-ordination of that information. The results consisted of 31 different recommendations ranging from a new purchasing policy (which meant long range planning rather than day-to-day buying) to improvement in plant layout.

The speaker's reference to determining what the real problem *is* shows that Mr. DePoy has been there too! Proper engineering requires that every facet of a problem be investigated. Then, the engineer-co-ordinator can distinguish between looking at only the trees and at the whole forest.

When a feasibility study is presented, management is not interested necessarily in whether the bath of an open hearth should be an inch deeper; not necessarily whether the "cost above" can be cut by 50¢; and not necessarily whether the rolling capacity can be exceeded by 2 per cent. The problem should be simply stated and usually it is, "Can it be done and for how much?" After thorough study, the answer can be stated very briefly that: (1) the project is feasible, (2) that it will cost a certain amount of money, (3) that it can be built in a certain amount of time, and (4) will show a reasonable return on the investment.

An interesting example along this line was a recent study of a pile casting facility where it was required that a great number of pile foundations be constructed over a period of years and the problem was to find ways and means of making more foundations.

The people who were working on the project wanted to increase operations and took the readily apparent or seemingly obvious approach of duplicating existing facilities to produce more of the same type of piling. In the course of our study, we consulted our structural engineer who developed an alternate pile design of equal strength using hollow core prestressed piles. This would require less concrete and would cost less, and present concrete-making facilities were adequate for the increased production.

In this example, the co-ordination between design engineers who determined what was required of the piling, the construction engineers who determined what the pile casting facilities would do and the operating personnel resulted in a proper engineering evaluation.

Mr. DePoy has today given us the opportunity to reappraise our efforts as engineers to determine whether we are really functioning properly as part of our company's team. The engineering function requires gathering of facts from many places and analyzing these facts using the engineer's discipline. Our techniques include cajoling, threatening, nagging and needling—the results are welded into a common language which can be understood by all.

PROGRAM

Association of Iron and Steel Engineers

1957 Annual Convention

HOTEL PENN-SHERATON PITTSBURGH, PA.

SEPTEMBER 23, 24, 25, 26

MONDAY, SEPTEMBER 23

9:00 am—REGISTRATION—
Fort Duquesne Room

9:15 am—BUSINESS MEETING—
Urban Room

Conducted by President J. D. O'Roark

9:30 am—ELECTRICAL SESSION—
Urban Room

Chairmen: John F. Kostelac, Assistant Electrical Superintendent, Crucible Steel Company of America, Midland, Pa.

E. L. Anderson, Superintendent Electrical Dept., Bethlehem Steel Co., Johnstown, Pa.

"Standardized Component Parts for Heavy Duty Mill Type Cranes," by Myron R. Bowerman, Director of Research, and Elvin R. Madison, Research Engineer, The Alliance Machine Co., Alliance, Ohio

"Increasing Open Hearth Capacity by Use of Light Weight Ladle Trolleys," by F. C. Schoen, Chief Engineer, Alan Wood Steel Co., Conshohocken, Pa.

"An Automatic Gage Control System for Tandem Cold Mills," by N. S. Walker, General Maintenance Foreman, Tin Mill Cold Reduction Dept., Gary Sheet and Tin Mills, United States Steel Corp., Gary, Ind., J. W. Cook, Steel Mill Engineer, Industry Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa., and J. W. Wallace, Mill Systems Development Engineer, Control Engineering Dept., Westinghouse Electric Corp., Buffalo, N. Y.

9:30 am—COMBUSTION SESSION—
Monongahela Room

Chairmen: F. B. Bevelheimer, Power and Fuel Engineer, Engineering Dept., Jones & Laughlin Steel Corp., Pittsburgh, Pa.

F. C. McGough, Superintendent, Maintenance and Construction, Detroit Steel Corp., Portsmouth, Ohio

"Open Hearth Fuel Atomization with Reaction Type Jet Burners," by G. W. Hinds, Development Engineer (Metallurgy), and A. L. Hodge, Staff Engineer (Metallurgy), Development Laboratory, Linde Co., Div. of Union Carbide Corp., Newark, N. J.

"Accelerated Firing Rates in Open Hearth Furnaces," by E. T. W. Bailey, Chief Combustion Engineer, The Steel Company of Canada, Ltd., Hamilton, Ontario, Canada

2:00 pm—MECHANICAL SESSION—
Monongahela Room

Chairmen: R. A. Kraus, Assistant Superintendent of Maintenance, Republic Steel Corp., Chicago, Ill.

E. F. Donatic, General Superintendent, Kaiser Steel Corp., Fontana, Calif.

"Magnetic-Flux Gas-Shielded Arc Welding," by J. E. Dato, Manager Eastern Region—Electric Welding, Linde Co., Div. of Union Carbide Corp., New York, N. Y.

"Railroad Car Rebuilds and Repair at Kaiser's Fontana Works," by A. B. Stoker, Foreman, Car Repair Shop, Kaiser Steel Corp., Fontana, Calif.

"Planned Maintenance Techniques for A Hot Strip Mill," by James R. Kennedy, Maintenance Foreman, Hot Mill Mechanical Dept., Pittsburgh Works Div., Jones & Laughlin Steel Corp., Pittsburgh, Pa.

2:00 pm—OPERATING PRACTICE SESSION—
Urban Room

Chairmen: G. I. Bottcher, Chief Engineer, Allegheny Ludlum Steel Corp., Brackenridge, Pa.

S. O. Evans, Manager, Tubing Operations, Tubular Products Div., Babcock & Wilcox Co., Beaver Falls, Pa.

"The Replacement of Steel Mill Plant and Equipment with Present Depreciation Reserves," by William T. Hogan, S.J., Professor of Economics and Director, Economics Program, Fordham University, New York, N. Y.

"Design of a Large Tonnage Continuous Casting Plant," by Rufus Easton, Manager Continuous Casting Section, Freyn Dept., Koppers Co., Inc., Pittsburgh, Pa., and Harold E. Skelley, Power and Fuel Engineer, Engineering Dept., Inland Steel Co., Indiana Harbor Works, East Chicago, Ind.

"The Dollars and Sense of Pickle Liquor Treatment," by James S. Joseph, Sales Engineer, and Elbert T. Culver, Senior Process Engineer, Chemical Dept., Engineering and Construction Div., Koppers Co., Inc., Pittsburgh, Pa.

TUESDAY, SEPTEMBER 24

9:00 am—ELECTRICAL SESSION—
Urban Room

Chairmen: D. C. McCrady, Superintendent, Electrical Dept., Steel Company of Canada, Ltd., Hamilton, Ontario, Canada

J. A. Drgon, Division Superintendent, Maintenance and Utilities, Edgar Thomson Works, United States Steel Corp., Braddock, Pa.

"Electrical Advances Can Reduce Installed Cost," by E. E. Vonada, Product and Application Specialist, Reliance Electric and Engineering Co., Cleveland, Ohio

"Protection Against Prolonged Delays on Main Drive Electrical Equipment," by H. H. Angel, Electrical Engineer, Construction Engineering Dept., Bethlehem Steel Co., Bethlehem, Pa.

"Selection of Electric Equipment for Temper and Skin-Pass Mills," by J. E. Peebles, J. J. Remley, and R. B. Eggleston, Steel Mill Engineers, Systems Application Engineering Section, General Electric Co., Schenectady, N. Y.

9:00 am—COMBUSTION SESSION—
Monongahela Room

Chairmen: R. A. Lambert, Superintendent, Steam Efficiency and Combustion Dept., Pittsburgh Works Div., Jones & Laughlin Steel Corp., Pittsburgh, Pa.

W. M. Bloom, Fuel Engineer, Allegheny Ludlum Steel Corp., Brackenridge, Pa.

"High Velocity Gas Stress Relieving Furnace," by Edward M. Yard, Chief Project Engineer, Mechanical, John A. Roebling's Sons Corp., Trenton, N. J.

"Fast Annealing of Sheet-Strip Coils with Helium Injection," by J. D. Keller, Partner, Associated Engineers, Pittsburgh, Pa.

"Continuous Annealing 60 Tons per Hour of Tinplate," by J. Neil Laidman, Engineer, Physical Metallurgy Section, Research Dept., Bethlehem Steel Co., Sparrows Point, Md., and Quentin M. Bloom, Manager, Furnace and Kiln Div., Selas Corp. of America, Dresher, Pa.

2:00 pm—OPERATING PRACTICE SESSION—
Urban Room

Chairmen: W. O. Bishop, Superintendent Blast Furnaces, Inland Steel Co., East Chicago, Ind.

John M. Walsh, Assistant General Superintendent, Gary Steel Works, United States Steel Corp., Gary, Ind.

"Modern Methods of Iron Ore Reduction," by H. W. McQuaid, Consulting Metallurgical Engineer, Cleveland, Ohio

"Techniques in Rebuilding a Blast Furnace," by C. F. Bessent, Supervisor, Mechanical Maintenance Dept., Bethlehem Steel Co., Sparrows Point, Md.

"Distributing Raw Materials in Blast Furnaces," by Henry W. Campbell, Chief Engineer, Interlake Iron Corp., Cleveland, Ohio

2:00 pm—LUBRICATION SESSION—
Monongahela Room

Chairmen: C. A. Bailey, Lubrication Engineer, National Tube Div., United States Steel Corp., Pittsburgh, Pa.

C. T. Lewis, Chief Lubrication Engineer, Republic Steel Corp., Cleveland, Ohio

"The Importance of Pumpability and Heat Stability in Industrial Greases," by Wm. A. Magie, 2nd, Vice President, Magie Bros. Oil Co., Franklin Park, Ill.

"Important Considerations in the Design of Modern Centralized Lubricating Systems," by G. C. Almasi, Materials and Standards Engineering Div., Crucible Steel Company of America, Midland, Pa.

"Development and Application of Spray Lubrication," by E. J. Gesdorf, Senior Application Engineer, The Farval Corp., Cleveland, Ohio

6:00 pm—OLD TIMERS DINNER—
Urban Room

WEDNESDAY, SEPTEMBER 25

9:00 am—ROLLING MILL SESSION—
Urban Room

Chairmen: A. M. Cameron, Superintendent, Blooming and Bar Mills, Atlas Steels, Ltd., Welland, Ontario, Canada

R. C. Schaefer, Superintendent Hot Strip Mill, Wheeling Steel Corp., Steubenville, Ohio

"Automatic Contour Turning of Large Mill Rolls," by William Hyams, Manager of Machinery Sales, Mackintosh-Hemphill Div., E. W. Bliss Co., Pittsburgh, Pa.

"Some Practical Solutions to Hot Mill Problems," by R. A. Smith, Assistant General Foreman, and A. D. Patton, Assistant to General Foreman, 96-In. Hot Mill, Pittsburgh Works Div., Jones & Laughlin Steel Corp., Pittsburgh, Pa.

"Application of Stretch Reducing of Tubes—For Greater Production and Economy," by William Rodder, First Vice President, The Aetna-Standard Engineering Co., Pittsburgh, Pa.

9:00 am—LUBRICATION SESSION—
Monongahela Room

Chairmen: A. E. Cichelli, Lubrication Engineer, Construction Engineering Dept., Bethlehem Steel Co., Bethlehem, Pa.

D. E. Whitehead, Materials and Standards Engineer, Crucible Steel Company of America, Pittsburgh, Pa.

"Large Motor Bearings," by Walter T. Saveland, Jr., Supervisory Engineer, Renewal Parts and Service, Motor and Generator Dept., Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

"Maintenance of Oil Film Bearings on European Mills," by Samuel Carson, Field Engineer, Morgan Construction Co., Worcester, Mass.

"Ten Painting 'Reminders' for Steel Plants," by Walter T. Yarhouse, Industrial Sales Representative, The Sherwin-Williams Co., Cleveland, Ohio

2:00 pm—OPERATING PRACTICE SESSION—
Urban Room

Chairmen: R. W. Holman, Director of Control Mechanisms Research, Research and Technology Div., United States Steel Corp., Pittsburgh, Pa.

Emil Kern, Vice President in Charge of Engineering, Allegheny Ludlum Steel Corp., Brackenridge, Pa.

"Steel Industry in Mexico—Its Present and Immediate Future," by Pascual Gutierrez Roldan, Managing Director, Altos Hornos de Mexico, S. A., Mexico, D. F.

"The Steel Industry in India—Yesterday, Today and Tomorrow," by E. T. Warren, President, Tata, Inc., New York, N. Y.

"European Steelmaking Today—The Technical and Economic Picture," by Alastair McLeod, Editorial Director-Technical, Industrial Newspapers, Ltd., Adelphi, London, England

2:00 pm—ELECTRICAL SESSION—
Monongahela Room

Chairmen: R. G. Nolan, Electrical Engineer, Granite City Steel Co. Granite City, Ill.

R. T. Winterringer, Assistant Superintendent, Electrical Dept., Republic Steel Corp., Chicago, Ill.

"Light Flicker Caused by Electric Steel Furnaces," by W. E. Schwabe, Product and Process Development Laboratories, National Carbon Co., Div. of Union Carbide Corp., Niagara Falls, N. Y.

"Trends in Ingot Buggy Design," by H. G. Frostick, General Supervisor Design Engineering (New Mills Construction), South Works, United States Steel Corp., Chicago, Ill.

"Blast Furnace Automatic Charging Control System," by S. P. Curtis, Chief Engineer, Fairless Works, United States Steel Corp., Fairless Hills, Pa., R. F. Schramm, Chief Electrical Engineer, Arthur G. McKee & Co., Cleveland, Ohio, and D. W. Fath, Senior Engineer, Cutler-Hammer, Inc., Milwaukee, Wis.

7:00 pm—FORMAL DINNER—Ball Room

Speaker: George Jason

10:00 pm—DANCE—Urban Room

AISE members and guests. No admission charge.

THURSDAY, SEPTEMBER 26

9:00 am—COMBUSTION SESSION—
Urban Room

Chairmen: G. H. Krapf, Division Superintendent, Power Production, South Works, United States Steel Corp., Chicago, Ill.

F. R. Pullen, Fuel Engineer, Bethlehem Steel Co., Johnstown, Pa.

"Trends in Steel Mill Power Plants," by Howard G. Kitt, Senior Power Engineer, and Robert W. Worley, Chief Power Engineer, United Engineers & Constructors, Inc., Philadelphia, Pa.

"Gas Storage for Peak Demands," by Robert Kyle, Vice President, The Gas Machinery Co., Cleveland, Ohio

"New Combustion Process for Temperature Uniformity in Heat Treating Furnaces," by F. C. T. Daniels, Consultant, and Steve Stasko, Assistant Chief Metallurgist, Mackintosh-Hemphill Div., E. W. Bliss Co., Pittsburgh, Pa.

9:00 am—MECHANICAL SESSION—
Monongahela Room

Chairmen: H. R. Knust, Assistant General Manager, Bethlehem Steel Co., Sparrows Point, Md.

L. A. Fugassi, Assistant Chief Engineer, Weirton Steel Co., Div. of National Steel Corp., Weirton, W. Va.

"Safeguarding Steel Production," by R. M. L. Russell, Assistant Chief Engineer, Factory Insurance Association, Hartford, Conn.

"Some Heavy Industrial Noise Problems, Their Analyses and Solutions," by Richard D. Lemmerman, Manager, and Richard R. Audette, Assistant Chief Engineer, Industrial Sound Control Dept., Koppers Co., Inc., Baltimore, Md.

"Treatment of Water-Borne Wastes from Steel Plants," by Ross Nebolsine, President, Hydrotechnic Corp., New York, N. Y.

2:00 pm—OXYGEN SESSION—
Urban Room

Chairman: J. H. Strassburger, Assistant Vice President, National Steel Corp., Pittsburgh, Pa.

"Summary of Operating Results with Oxygen," by J. H. Strassburger, Assistant Vice President, National Steel Corp., Pittsburgh, Pa.

"Benefits of Purchased Oxygen to the Indiana Harbor Works of the Inland Steel Company," by N. R. Kirkdoffer, Superintendent, Power, Steam and Combustion Depts., Inland Steel Co., East Chicago, Ind.

"Economics of Generated Versus Purchased Oxygen for Steel Plant Use," by R. A. Lambert, Superintendent, Steam Efficiency and Combustion Dept., Pittsburgh Works Div., Jones & Laughlin Steel Corp., Pittsburgh, Pa.

"Oxygen Plant Cycles Tailored to the Requirements of Iron and Steel Producers," by Clarence J. Schilling, Vice President and Chief Engineer, Air Products, Inc., Allentown, Pa.

"Operation and Maintenance of a 100-Ton Double-Cycle, Gaseous Oxygen Plant," by G. T. Wright, Mechanical Superintendent, Dominion Foundries and Steel, Ltd., Hamilton, Ontario, Canada

"Maintenance Experience with Oxygen Plants at Sparrows Point," by A. Stutzer, General Foreman, Prepared Gases Station, Fuel Dept., Bethlehem Steel Co., Sparrows Point, Md.

2:00 pm—ELECTRICAL SESSION—
Monongahela Room

Chairmen: R. T. Lucas, Electrical Superintendent, Weirton Steel Co., Div. of National Steel Corp., Weirton, W. Va.

C. L. Squier, Assistant Electrical Superintendent, Bethlehem Steel Co., Lackawanna, N. Y.

"Recent Hot Strip Mill Roughing Trains," by John H. Greiner, Application Engineer, Electrical Application Dept., Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

"Practical Aspects of Power Layouts for Steel Mills," by A. J. Mosso, Vice President, Auburn & Associates, Inc., Pittsburgh, Pa.

"Constant Horsepower Computer—Permitting the Use of Slip Coupling for Winder Drives," by P. R. Gravenstreter, Electrical Engineer, The Clark Controller Co., Cleveland, Ohio

LADIES PROGRAM

Ladies Headquarters and Registration—
Parlors E-F, Hotel Penn-Sheraton

Monday, September 23.....Tea

Tuesday, September 24.....Luncheon

Wednesday, September 25.....Kaffee Klatsch
Formal Dinner
Dance

Honorary Chairwoman: Mrs. J. D. O'Roark

General Chairwoman: Mrs. R. B. Schnure

Vice Chairwoman: Mrs. J. L. Young

To partially cover costs, a flat registration charge of $5.00 will be made which will cover all ladies activities except the formal dinner on Wednesday evening. This must be paid on registering, when tickets will be issued for these events.

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CLAYTON L. SQUIER

Abstracts of Technical Papers

to be

presented at technical sessions of

AISE ANNUAL CONVENTION

September 23, 24, 25, 26, 1957

HOTEL PENN-SHERATON **PITTSBURGH, PA.**

"STANDARDIZED COMPONENT PARTS FOR HEAVY DUTY MILL TYPE CRANES"

by MYRON R. BOWERMAN, Director of Research, and ELVIN R. MADISON, Research Engineer, The Alliance Machine Co., Alliance, Ohio

M. R. BOWERMAN

▲ MOST steel mill cranes in this country, including special purpose cranes, are built to comply with customer requirements and AISE specifications. However, many component parts and assemblies may well be alike, or similar, to corresponding parts of another crane of similar capacity.

By establishing ranges of bridge and trolley wheel loads and hoist capacities, we have developed bearing and gear arrangements to suit these wheel loadings and hoist capacities, and also gear housings and supports for motors and brakes to take such gear and bearing arrangements. Then by varying gear ratios within these housings, required speeds are attained. Arrangement and detail drawings thus developed are used in various combinations to obtain required results.

E. R. MADISON

Special cranes, such as soaking pit, stripping and ladle cranes have bridge and trolley drives and auxiliary hoists like, or similar to standard drives and hoists and may use many standard component parts with perhaps varying factors of safety.

End carriages and trucks are designed with bearing seats to take any of several types of anti-friction bearing housings or sealed bronze bearings.

Standardized parts and mechanisms, applicable for a range of sizes, greatly reduces the number of totally different designs. The amount of engineering work is reduced. Fewer patterns and templates are required. Earlier delivery is possible. The customer has an advantage in that he will need less spares, parts are usually stronger and replacements may be produced more quickly.

"INCREASING OPEN HEARTH CAPACITY BY USE OF LIGHT WEIGHT LADLE TROLLEYS"

by F. C. SCHOEN, Chief Engineer, Alan Wood Steel Co., Conshohocken, Pa.

F. C. SCHOEN

▲ ALAN Wood Steel Co. had increased the heat size in its open hearth shop to a point which overloaded the capacity of its ladle cranes. The ladle cranes built in 1917 of 150-ton capacity had the usual trolley design using castings and riveted fabrication.

Redesign of the trolleys using weldments and improved quality steel, along with some departures in arrangement, gave a weight reduction of 35,000 lb with an increase in capacity of 33½ tons.

Taking advantage of these facts permitted increase in open hearth heat size which could be handled in a single ladle.

These facts were then evaluated using a modification of the MAPI formula which when completed showed better than a 33 per cent return. This was sufficient justification to install new trolleys on the three ladle cranes in Alan Wood's open hearth shop.

The paper makes comparisons of several designs and compares components of the old and new trolleys indicating design changes and weight reductions, as well as showing details on the use of MAPI formula for economic justification.

"AN AUTOMATIC GAGE CONTROL SYSTEM FOR TANDEM COLD MILLS"

by N. S. WALKER, General Maintenance Foreman, Tin Mill Cold Reduction Dept., Gary Sheet and Tin Mills, United States Steel Corp., Gary, Ind., J. W. WALLACE, Mill Systems Development Engineer, Control Engineering Dept., Westinghouse Electric Corp., Buffalo, N. Y., and J. W. Cook, Steel Mill Engineer, Industry Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa.

N. S. WALKER

▲AN automatic gage control system was placed in operation on a Chicago area five stand tandem cold mill approximately two years ago. This system consisted of a coarse control on the screws of the No. 1 stand which jogged the screws (when the No. 1 stand exit gage deviation exceeded a certain value) and a continuous regulating type control which controlled speed of the first, second, fourth and fifth stands from an x-ray gage following the No. 5 stand.

Within the last year the continuous regulating control has been redesigned and rebuilt so that it is now essentially an all magnetic amplifier system.

J. W. COOK

In the design of a regulating system of this sort a direct acting regulator (one which has a correcting output voltage proportional to input error signal) is generally used. Another type regulator which may be used is an integrating servo which supplies a permanent corrective action proportional to the time integral of the input error. The integrating servo requires no steady state error to maintain its corrective action.

For this mill it was decided to use both regulators tied together in a system so as to obtain a fast transient response with the direct acting regulator and to obtain an extremely high steady state gain with the integrating servo.

J. W. WALLACE

Performance of the system has shown that this choice was justified.

On mill acceleration and deceleration, where gage error tends to be large, the direct acting regulator supplies practically all of the corrective action. However, once the mill is up to speed, and errors in gage are rather small and strip thickness changes rather gradually, the integrating servo furnishes practically all of the corrective action.

The output of the direct acting regulator and the integrating servo are mixed and amplified in a power magnetic amplifier which in turn feeds the total correction voltage to control fields of the IR compensation regulators on the stand generators.

The system is essentially of all magnetic amplifier construction and is simple in circuitry. All components are of standard heavy duty industrial design.

The new control was installed without incident, and no changes in test floor settings were required. The control was turned in gradually, and it functioned effectively from the start. The operators are pleased with this control and they use it voluntarily.

With the gage control switch turned to the "Automatic" position the manual control is still operative. However, if manual control is in the wrong direction to correct gage, the automatic system will attempt to override the manual adjustment.

This system is extremely versatile. It can use an input signal from any measuring device which will operate a standard meter, and it can supply a correction voltage to any one or any combination of control devices.

Recording instruments indicate that this automatic system provides a marked improvement over the old manual control.

Although this paper deals with automatic gage control as applied to tandem mills, this gage regulating system is applicable to any rolling mill where gage can be controlled by tension.

"OPEN HEARTH FUEL ATOMIZATION WITH REACTION TYPE JET BURNERS"

by G. W. HINDS, Development Engineer (Metallurgy) and A. L. HODGE, Staff Engineer (Metallurgy), Development Laboratory, Linde Co., Div. of Union Carbide Corp., Newark, N. J.

G. W. HINDS

▲ THE energy of a jet reaction flame has been successfully employed to atomize liquid fuels in open-hearth furnaces. Extensive tests covering 700 to 800 open-hearth heats have shown this method of fuel atomization to be practical and economical. Compared with standard steam atomization, jet atomization has increased steel production, and lowered fuel consumption with up to 30 per cent higher firing rates.

The jet burner utilizes a hot gaseous flame at high velocity to atomize and preheat the main liquid fuel before burning. The hot gases and energy of the jet are obtained by burning a small amount of gaseous or liquid fuel with air or oxygen under pressure in a specially designed combustion chamber located in the rear of the burner. Atomization of the main liquid fuel is then accomplished by injecting the liquid fuel directly into the hot gas stream. Temperature and velocity of the jet flame depend on operating conditions and will vary in the ranges of 3000 to 4000 F and 1000 to 1500 fps, respectively.

A. L. HODGE

The principal difference between jet and steam atomization is that jet atomization produces a faster burning flame at a higher temperature with increased thermal radiation to the bath. Three factors are responsible for this condition: (1) temperature of steam atomized oil is approximately 300 F, compared with

900 F or more for jet atomized oil, (2) steam decreases the available heat in the high temperature zone through absorption of sensible heat and consumption of heat of chemical dissociation, and (3) oil subjected to the high temperature of the jet flame undergoes pyrolysis and vaporization in addition to extreme atomization.

Measurements of maximum thermal radiation intensity of the flame in the spectral range of 0.2 to 10 microns showed an increase in radiation of 15 to 20 per cent for jet over steam-atomized oil flames with other furnace conditions similar.

Higher firing rates and more efficient heat liberation to the charge with jet atomization has resulted in production increases of 8 to 12 per cent compared with steam atomization. Corresponding oil consumption was decreased about 10 per cent and no detrimental effect on refractories has been noted.

"ACCELERATED FIRING RATES IN OPEN HEARTH FURNACES"

by E. T. W. BAILEY, Chief Combustion Engineer, The Steel Company of Canada, Ltd., Hamilton, Ontario, Canada

E. T. W. BAILEY

▲ AMONG the many interesting items which surround the operation of all open hearth furnaces, is the rate of firing. It has long been known that the rate at which heat is developed in a furnace has a very direct bearing upon its output. However, it is only during the past ten years that this item has been given the attention it deserves.

The paper deals with methods employed at Stelco's No. 3 open hearth shop, during the last four years to bolster the rate of firing. The results obtained are indicated by figures and graphs. Reference is also made to improvement in the No. 2 shop production.

"MAGNETIC-FLUX GAS-SHIELDED ARC WELDING"

by J. E. DATO, Manager Eastern Region—Electric Welding, Linde Co., Div. of Union Carbide Corp., New York, N. Y.

J. E. DATO

▲ THERE have been many advances made in the fabrication of carbon steel during the past 25 years. This includes the introduction of improved electrodes for hand welding, and fully automatic processes are used in a good percentage of the carbon steel welding market.

The developments that led to this new process are aimed at the broad field that is adaptable to semiautomatic welding operation. This process includes mechanized control of the continuous wire feed and yet is adaptable to manual operation. The welding wire is continuously coated with a magnetic fluid that is fluidized in a gas stream and carried to the welding torch, where it is magnetically attached to the welding wire.

This paper describes the process and the equipment used in detail. Adaptability as to position welding is also discussed.

Weld quality and mechanical properties and many applications of the present day use of the process are discussed.

"RAILROAD CAR REBUILDS AND REPAIRS AT KAISER'S FONTANA WORKS"

by A. B. STOKER, Foreman, Car Repair Shop, Kaiser Steel Corp., Fontana, Calif.

A. B. STOKER

▲ THE primary function of this shop has changed from repairing damaged railroad cars to not only repairing but also rebuilding railroad cars. The rebuilding program has brought about many changes in car construction. Less expensive cars are being built than those obtained by purchase, and they are much more easily adapted to needs. Excellent success is being obtained with rebuilt gondola cars, as can be readily seen in the pictures to be shown.

The flat cars and dump cars have been considerably strengthened, and the dump cars have a new type of dump door activating system. Construction techniques for all three types of cars mentioned are discussed.

A new method for changing the trucks on the ladle cars which carry the hot iron from the blast furnaces to the pig caster, foundry, and open hearths has been devised. It has been a tremendous advantage to eliminate the necessity of using an open hearth ladle crane to change the trucks.

"PLANNED MAINTENANCE TECHNIQUES FOR A HOT STRIP MILL"

by JAMES R. KENNEDY, Maintenance Foreman, Hot Mill Mechanical Dept., Pittsburgh Works Div., Jones & Laughlin Steel Corp., Pittsburgh, Pa.

J. R. KENNEDY

▲ MAINTENANCE techniques, by any other name, are merely methods and applications by which the innumerable problems that face the present-day industrial maintenance supervisor, are brought to a conclusion. In choosing to discuss this broad-scoped subject, it must be realized that many specific problems which are peculiar to particular installations cannot be resolved at this time.

There are, however, basic fundamental activities that are a common pitfall to many maintenance people throughout the steel industry. There are also undoubtedly nearly as many solutions being satisfactorily used by the industrial maintenance supervisor as there are number of common problems. This paper will deal with a few of these problems and the methods being used in one large steel producer's plant.

It is agreed that maintenance is a necessary evil, but it is seldom explained as to why this is so. Maintenance results from a cause, such as corrosion of materials, friction, fatigue, improper operation of equipment, wrecks, etc. These causes must be kept under control if

the fundamental purpose of business, namely, making a profit, is to be realized.

A very important step in the development of a planned maintenance program is the establishment of a clear-cut definition of the maintenance crews' function, i.e., just what is expected of the maintenance crew? What responsibility and what authority do they have over operations to take a unit out of service for inspection or repair?

A key to the competitive position of a company is how well-controlled are its manufacturing costs, a very large proportion of which are incurred in maintenance and repair. How can better methods and better tools be utilized by maintenance people in order to better control their costs?

The last line of defense to be used in good maintenance planning is provided by the maintenance departments' various inspections. Inspections should never be minimized, regardless of the type of inspection designated. Adequate coverage of equipment by inspection is contingent on the various kinds of inspections. There are the simple inspections in which nothing more is necessary than reading a pressure gage or a temperature indicator. Then there are very exacting inspections in which measurements of bearings, tolerances, cylinder wall wear, etc., must be taken and recorded on a history chart so that subsequent inspections of the same equipment will have a reference point for determining maintenance requirements on the equipment.

Planned maintenance functions smoothly only when all parties involved, whether they are the operating departments, the design engineering department, or the maintenance department, are cognizant of the fact that they must all work together—no single one of them can make a go of it alone! Operating departments must do their share by properly using the equipment and not abusing it; maintenance personnel contribute by constant detection and adequate correction of bad conditions and by introducing new and better methods in order to minimize downtime and delays due to maintenance malfunctions; the design engineer contributes by producing the best available design in order to lighten the burden of the operating departments and the maintenance departments. Integrating the requirements and the functions of these main-stays of modern industry provides the challenge and the goal toward which the good maintenance man of today is constantly striving.

"DESIGN OF A LARGE TONNAGE CONTINUOUS CASTING PLANT"

by RUFUS EASTON, Manager Continuous Casting Section, Freyn Dept., Koppers Co., Inc., Pittsburgh, Pa. and HAROLD E. SKELLEY, Power and Fuel Engineer, Engineering Dept., Inland Steel Co., Indiana Harbor Works, East Chicago, Ind.

RUFUS EASTON

▲ CONTINUOUS casting as a process for producing semi-finished products has been attractive to the steel industry for many years because of the apparent advantages of lower initial cost per ton of installed capacity, reduced operating costs, and increased yield from molten steel to semi-finished product. The process is operating commercially in several steel plants, primarily abroad, and on the basis of the techniques and equipment developed in these installations, a sound approach to the design of a plant for producing large tonnages may be defined.

Basic considerations are: presently successful equipment and operating techniques; the nature and practices of the melt shop with which the plant is to be allied; and anticipated future developments. As a first step, the limiting dimensions of a single strand must be established, including machine speed, width and thickness of the cast section, casting rate, machine availability and annual capacity. From these, and the size of the steelmaking furnace, the number of strands required to cast one heat of steel in one hour is determined. The tap-to-tap time for a single furnace, the number of furnaces in the melt shop, and the metal availability will establish the number of casting units required in the plant.

H. E. SKELLEY

The paper explores the application of these principles, to the design of continuous casting plants for both new and existing open hearth, electric furnace, and oxygen converter steel-making shops. Suggested plant designs are presented, and the advantages and disadvantages of each are discussed.

"THE REPLACEMENT OF STEEL MILL PLANT AND EQUIPMENT WITH PRESENT DEPRECIATION RESERVES

by WILLIAM T. HOGAN, S. J., Professor of Economics and Director, Economics Program, Fordham University, New York, N. Y.

W. T. HOGAN, S. J.

▲ THERE is a paradox in the steel industry today. Despite record dollar profits, the industry has pressing financial problems. Dollar income after taxes for both 1955 and 1956 was in excess of 1,000,000,000, yet capital requirements are so great that the proper replacement and modernization of plant and equipment present difficulties.

The problem arises from increasing costs, declining purchasing power of the dollar and inadequate depreciation reserves. The cost of replacing plant and equipment has risen 100 to 200 per cent in the last fifteen years. Depreciation reserves can provide only one-third to one-half of replacement requirements, and thus supplementary funds must be acquired. These were obtained in part from five year write-offs permitted by certificates of necessity, but this source has almost dried up.

The source of new funds could conceivably come from three sources:

1. Borrowed money—this might be possible for one or

two years, but is unsound as a continuing practice and would lead to bankruptcy.

2. An issue of additional stock—such a practice, if adopted for the mere replacement of assets, would dilute the equity of current stockholders in the physical plant. Further, it is difficult to see how anyone would want to buy stock in a company which is not making enough to replace its plant and equipment.

3. The investment of retained earnings—the course followed by most companies.

The large scale annual investment of retained earnings for the replacement of plant and equipment has a decided impact on profits, wages and prices, productivity and our standard of living.

1. Profits are over-stated, for if adequate depreciation were taken, the $1,000,000,000 figure for 1955 and 1956 would be reduced to $800 to $900,000,000.

2. High prices must be maintained so that sufficient profits are earned to cover replacement costs. This is particularly true in view of the fact that $2.00 must be earned before taxes for every dollar of profits invested.

3. The reinvestment of earnings is a necessity if productivity is to be maintained and increased.

The possible remedy for depreciation problems lies in a realistic tax policy. This should be based on the fundamental concept of depreciation which was evolved from the fact that capital wears out at a fraction of its value each year. Because of this basic premise, it is difficult to make accurate predictions on replacement needs for: (1) a forecast of the life of the capital involved is required, which is difficult since a piece of equipment may have five years longer or shorter life than predicted; (2) the evaluation of plant and equipment changes due to obsolescence and fluctuations in the price level.

Therefore, the solutions will have to be based on flexible norms which can be adjusted to meet the above conditions.

"THE DOLLARS AND SENSE OF PICKLE LIQUOR TREATMENT"

by JAMES S. JOSEPH, Sales Engineer, and ELBERT T. CULVER, Senior Process Engineer, Chemical Dept., Engineering and Construction Div., Koppers Co., Inc., Pittsburgh, Pa.

J. S. JOSEPH

▲ PICKLING situations may be classified by two criteria, the type of pickling machine involved, that is whether batch or continuous, and the capacity in terms of spent solution produced which may range from less than 5000 gal per week to over 200,000 gal per day. Both the type and capacity must be further subdivided by the analysis of the metal processed and therefore by the acid used to effect scale removal.

Treatment methods are also of two general types, destructive and regenerative. Of the destructive variety, neutralization and hauling for disposal are among the most common. Regeneration by the removal of ferrous sulphate heptahydrate or by the removal of the monohydrate are among the most widely practiced methods for recovering the free acid value of the spent liquor.

E. T. CULVER

The selection of the particular treatment to be applied to a specific pickling situation is not always obvious. The paper therefore includes the technical, functional and economic factors affecting a final choice. To substantiate this information, each process is described and their ability to solve various pickle liquor disposal problems is discussed in some detail.

Since economics are the fundamental basis for any selection, cost studies for each process are presented based on typical applications and using standard utility, labor and fixed cost rates. Such figures will, of course, have to be modified to fit individual situations, but will nevertheless be a close approximation of the comparative costs of pickle liquor treatment.

"ELECTRICAL ADVANCES CAN REDUCE INSTALLED COST"

by E. E. VONADA, Product and Application Specialist, Reliance Electric and Engineering Co., Cleveland, Ohio

E. E. VONADA

▲ SINCE more and more steel mill operations can be accomplished better electrically, electrical equipment has become a larger percentage of the total invested capital. Since total capital expenditure is normally the yardstick governing the installation of new facilities or modification of existing facilities, steps to reduce electrical drive and installation costs are in order.

Many of the specifications for electrical equipment and installation used today were evolved during the depression years of the 1930's. At that time, electrical equipment and its installation represented between 30 and 40 per cent of the total cost of a complete processing line; today for a similar line, installation costs alone are equal to or greater than the total electrical and mechanical equipment costs, if installations are continued to be made according to the 1930 standards.

With this situation, either the rapid pace of advancement must diminish, or the newly developed electrical equipment and installation techniques and accessories must become acceptable. Some suggestions for this latter course of action will be covered in the paper to be presented. For one, it will be necessary for engineering production, and maintenance personnel to work together harmoniously. Numerous small steel companies and several of the larger companies have made tremendous strides forward by accepting this course.

From an engineer's standpoint there is nothing more beautiful than a large, well-lighted, ventilated, attractively painted, centralized motor-generator and control room. These rooms, along with their associated lengths of conduit and cable runs, are common to steel mills, but are expensive. Can they continue to be economically justified?

"SELECTION OF ELECTRIC EQUIPMENT FOR TEMPER AND SKIN-PASS MILLS"

by J. E. PEEBLES, J. J. REMLEY, and R. B. EGGLESTON, Steel Mill Engineers, Systems Application Engineering Section, General Electric Co., Schenectady, N. Y.

J. E. PEEBLES

J. J. REMLEY

R. B. EGGLESTON

▲ TEMPER mills as a class includes mills ranging from simple, slow single-stand sheet mills to complicated high-speed two-stand tin-plate mills. This paper is intended to give an insight into the problems which should be considered when electric equipment is selected for mills of this type.

The procedure for selecting machine size is clarified by sample calculations. The complete machine rating is considered including field range and possible physical specifications and limitations. The possible types or arrangement of power supply are discussed. Ratings of some existing mills are presented in a form to allow a quick comparison with any contemplated mill.

Various conventional control systems are functionally described as well as special features which are available for such systems.

Some thoughts are presented as to possible future developments of temper mill equipment and how automation may possibly be applied in this general area.

This paper should aid the mill owner to select his equipment wisely and take full advantage of the equipment and control now made possible through product development in the electrical industry.

"PROTECTION AGAINST PROLONGED DELAYS ON MAIN DRIVE ELECTRICAL EQUIPMENT"

by H. H. ANGEL, Electrical Engineer, Construction Engineering Dept., Bethlehem Steel Co., Bethlehem, Pa.

H. H. ANGEL

▲ THIS paper deals principally with complete spare units suitable for one or more plants of the Bethlehem Steel Co. and touches lightly on major spare parts for main drive equipment.

Past experience is the guide in determining when full sets of spare coils should be kept on hand and what steps should be taken, under a preventive maintenance program, to rewind specific units.

The Bethlehem Steel Co. has a number of spare armatures for main drive motors and generators. Two of these are mounted on special railway cars and are suitable for two or more plants. An illustrated description, including the maintenance problems, transportation and installation, is given. Data on other spares is also given.

In one plant, a unique arrangement is made for the installation of a 6000-kw rectifier to operate at 60 cycles to reduce 25-cycle loading and to release equipment which will serve as spares for three different locations.

Maintenance departments may not always be able to obtain all the spares they consider necessary. However, they must be on the alert, as risks become greater, to call management's attention to prolonged delays and loss of product which might result from major failures.

"HIGH VELOCITY GAS STRESS RELIEVING FURNACE"

by EDWARD M. YARD, Chief Project Engineer, Mechanical, John A. Roebling's Sons Corp., Trenton, N. J.

E. M. YARD

▲ IN 1956 we were faced with the problem of designing equipment to stress relieve a steel wire strand $\frac{3}{8}$ in. in diameter in quantities of one to two tons an hour. It was required that the equipment be economical to build and to operate. It was essential that the process be closely controlled in order to obtain uniform physical properties and to meet close specifications.

Many types of furnaces were considered. Most of these were eliminated because of high first cost, high operating cost, and control problems. The lead pan used during product development was abandoned because of lead drag out in the strand. The high velocity gas furnace was chosen to best perform this stress relieving function.

It was necessary to develop a design method, as no applicable data was found to allow the heating rate to be figured. This method was based upon a hypothesis of the dependence of heating rate on the mass flow of circulated gases. Data from preliminary tests was used to determine the assumptions for the final design.

Actual performance of the furnace designed according to this hypothesis was within the expected range. The equipment is responsive and easily controlled. Heat-up time is a matter of minutes.

The unit is of the recirculating type with hot fan and direct fired gas heater. It has two zones and fully automatic controls. Operating costs and maintenance are low. Product quality has been high and specifications are easily met.

"FAST ANNEALING OF SHEET-STRIP COILS WITH HELIUM INJECTION"

by J. D. KELLER, Partner, Associated Engineers, Pittsburgh, Pa.

▲ INJECTION of helium into the narrow spaces existing between the wraps or layers of strip wound in coils, displacing the air originally present in these

J. D. KELLER

spaces and substituting the highly conductive helium gas, effects a five-fold increase in the capacity of the coils for conducting heat radially inward or outward. This can speed up the heating and cooling, and greatly increase the output of annealing bases and covers, without requiring the use of high-power recirculating fans.

Demonstration with identical coils, about 4 in. in diameter, of 0.009 in. thick cold-reduced steel strip, both coils being supplied with heat at the same rate, shows a remarkable decrease in the time required for heat to penetrate the helium-injected coil as compared with the ordinary air-containing coil.

Economically, the process is attractive, for although helium is a fairly expensive gas, so little of it is needed to fill the 3 per cent void spaces in the coils (about $\frac{1}{8}$ cu ft per ton of strip) that even with an extremely generous allowance for purging, the cost of the helium, if supplied in fairly large quantities, should not exceed 3¢ per ton of strip.

What has delayed the adoption of the process up to the present is the supposed difficulty of forming fairly gas-tight seals between the inner and outer edges of the coils and the hollow spacers through which the helium is injected; the difficulty being due chiefly to varying outside diameters of the coils. This is by no means insurmountable, however, and designs of spacers and seals have been devised which should overcome the difficulty.

With this problem solved, the use of helium injected may lead to a revolution in coil annealing practice, by dispensing with the inner covers and yet permitting direct flame firing. All but the outermost layer of the coil being protected by the non-reactive helium, and the latter conducting heat inward so fast that it would be impossible to overheat the outer layers or the edges, it should be possible, with direct firing and water-spray cooling, easily to double and possibly to triple the best present production rates, with equal or better uniformity of annealing.

"CONTINUOUS ANNEALING 60 TONS PER HOUR OF TINPLATE"

by J. NEIL LAIDMAN, Engineer, Physical Metallurgy Section, Research Dept., Bethlehem Steel Co., Sparrows Point, Md., and QUENTIN M. BLOOM, Manager, Furnace and Kiln Div., Selas Corp. of America, Dresher, Pa.

J. N. LAIDMAN

▲ THIS paper discusses the characteristics and operation of four one-pass, direct-gas-fired furnace lines continuously annealing tinplate stock at the Sparrows Point, Maryland, plant of Bethlehem Steel Co.

Performance data and metallurgical information are presented to illustrate the reasoning and objectives of obtaining 60 tons per hour in a multiple-line installation.

Some of the highlighting features described, include:

1. How the unique, retractable furnace design provides improved safety measures.
2. How the compactness and simplicity of the entire installation reduces investment and operating costs.
3. How multiple-line flexibility of production helps coordination with varying market and product requirements.
4. How the one-pass design reduces operational difficulties.
5. How, in a complete annealing cycle of less than one minute, desired physical strip properties are obtained.

Q. M. BLOOM

"MODERN METHODS OF IRON ORE REDUCTION"

by H. W. McQUAID, Consulting Metallurgical Engineer, Cleveland, Ohio

H. W. McQUAID

▲ THIS paper discusses in a general way the present picture of the reduction of iron ore to produce a charge material for steel and iron making furnaces. It discusses the practices which seem to be in highest repute at the present time. It discusses the probable comparative future position of the blast furnace, and other methods of recovering iron from iron oxide.

The advantages of hot metal and the procedure necessary to follow to obtain it are discussed as well as the procedure which must be followed to obtain a cold metal direct from the ore. The economics of treating molten iron ore and its value in the integrated steel mill are discussed and compared with the reducing gas treated pulverized hot iron oxide.

The process to be adopted to produce the metal iron directly from the ore will depend to a large degree on the use to be made of the iron. If it is to be used to replace scrap as a charge material in the making of special high quality steel in the electric furnace or as a source of high purity iron powder for the powdered iron user, the use of hydrogen, carbon monoxide or a mixture of carbon monoxide and hydrogen is indicated. This product would be of little interest to the tonnage open hearth or electric furnace except to a very limited degree.

Some of the present day practices in using hydrogen and carbon monoxide are discussed and the basic differences in procedure are noted. The use of incompletely reduced iron oxide to produce a desirable mixture of iron scrap and iron oxide is noted for a melting practice such as the open hearth involving considerable carbon removal. The advantage of low cost natural gas is noted, as in Texas, and the improvement it gives to the economic position of the hydrogen reduction procedure as compared to other methods. In such locations where cheap natural gas or fuel oil is available, the selection of a method of reducing iron oxide based on

hydrogen from partially burned natural gas or fuel oil might be indicated.

Ore grade and degree of concentration is an important factor in direct reduction and must be carefully studied and related to the end product desired. When high grade concentrate is available, the position of any one of the hydrogen based reduction processes is greatly improved. Where the ore is of a lower grade and degree of concentration and the end use is based on high tonnage requirements, the treatment of the iron ore in the molten state with a cheaper source of carbon would seem to be the logical and natural method to be selected. It permits the melting and superheating of the ore under the better economy of fully oxidizing conditions and its extremely rapid and complete reduction to the metal iron with the proper contact with a cheap form of incandescent carbon. Non-metallics are separated incidental to melting and handling and the resulting big recovery of iron in liquid form makes it ideal for charging into open hearth or other types of steel melting furnaces.

"TECHNIQUES IN REBUILDING A BLAST FURNACE"

by C. F. BESSENT, Supervisor, Mechanical Maintenance Dept., Bethlehem Steel Co., Sparrows Point, Md.

C. F. BESSENT

▲ THIS paper furnishes a general description of techniques, innovations, and methods used in blast furnace repairs at the Sparrows Point plant of the Bethlehem Steel Co. All phases of the job, including planning, preparation, and performance of the relining are reviewed, with special emphasis placed on materials-handling systems and time-saving procedures. Slides of actual repair jobs are used in presentation of the paper.

In order to rebuild blast furnaces efficiently and economically, thorough planning is necessary. Coordination between engineering, blast furnace, electrical and mechanical departments is the forerunner of a smooth functioning job.

Of prime importance to a fast relining job is complete preparation. All materials must be neatly stocked at accessible locations. All checking and fitting of prefabrications must be done before use. Shaped brick for keys, miters, etc., is cut and clearly marked prior to the time it is needed. Electricity, air, oxygen, water and other service items are made available before the furnace is blown down. Carbon-lining blocks are preassembled to assure dimensional accuracy. Hoisting machinery is anchored in place and rigging hung where possible. Foundation alterations to auxiliary units are made while the furnace is still in operation. Railroad tracks are reconditioned at a convenient time before the repair is started. Tool and equipment repairs are made before the tools are delivered to the job site.

The various phases of "tear-down" are presented. Lancing salamander, flood-down, removal of top castings, and installation of the working scaffold must be expeditiously accomplished before tearing out is started. The value of adequate arrangements for removal of stock and rubble from the work area cannot be over-estimated. Explosives, when properly used, are an invaluable aid to hearth removal.

Of prime importance to the relining is a fast, efficient means of handling material to the bricklayers in the hearth and stack. "Techniques In Rebuilding A Blast Furnace" describes the entire materials-handling system as used at Sparrows Point. Integral parts of the system are illustrated by slides.

Also presented in this paper are facts and methods of procedure concerned with furnace auxiliaries and their repair, structural steelwork of the furnace proper, "drying out," and other related parts of the job.

"DISTRIBUTING RAW MATERIALS IN BLAST FURNACES"

by HENRY W. CAMPBELL, Chief Engineer, Interlake Iron Corp., Cleveland, Ohio

H. W. CAMPBELL

▲ THIS paper points out in general the ideas regarding the placement of raw materials in a blast furnace and some of the methods that have been and are being used to accomplish these results.

It deals particularly with the high speed top developed to give uniform distribution of raw materials both as to quantity and size circumferentially in the furnace. It lists the problems encountered in high speed operation of a distributor and the designs developed to give the best life to the component parts. It describes particularly the various methods tried and developed to seal the rotating element against leakage of gas from the top of the furnace.

Charts have been prepared to show the benefits obtained in production, coke rate and flue dust production on two blast furnaces over a period of about six years high speed top operation compared with three previous blasts on each of these same furnaces.

The increased lining life on six furnaces using the high speed distributor is described.

Motion pictures will show the results obtained in leveling the stock in a high speed distributor compared with the stationary hopper and at speeds under 20 rpm.

"THE IMPORTANCE OF PUMPABILITY AND HEAT STABILITY IN INDUSTRIAL GREASES"

by WM. A. MAGIE, 2ND, Vice President, Magie Bros. Oil Co., Franklin Park, Ill.

W. A. MAGIE, 2nd

▲ TESTS upon the pumpability and heat stability of industrial type greases give additional information about the service performance of a grease. Tests show that the ASTM drop point test and the penetrometer test cannot, by themselves, give indications of what a grease will do under a variable such as temperature. With this variable in mind, the author conducted tests upon

greases at temperatures ranging from 10 degrees to 200 F. A number of the commonly used industrial type greases were tested within this thermal range. The results, in many cases, were a great deal different from what might be anticipated from penetrometer and drop point tests (even at elevated temperatures).

"DEVELOPMENT AND APPLICATION OF SPRAY LUBRICATION"

by E. J. GESDORF, Senior Application Engineer, The Farval Corp., Cleveland, Ohio

E. J. GESDORF

▲ IN this paper the early history of centralized spray lubrication systems is traced to show how the initial successful installations led to widespread adoption of the equipment.

The operation of the measured spray mechanism is described. Different types of nozzles are discussed. The theory of nozzle spacing and arrangements with respect to the gear is covered.

The paper also evaluates spray patterns.

General information on the types of lubricants that can be handled in the centralized system is given for guidance in the selection of proper lubricants.

Steel mill spray system applications are discussed to illustrate the savings and benefits brought about by the use of this equipment.

In its present status, lubrication of open gearing by the spray method has been accepted as the most direct and economical method of lubrication developed to date. However, experience and knowhow play an important part in the engineering of successful spray system installations.

"IMPORTANT CONSIDERATIONS IN THE DESIGN OF MODERN CENTRALIZED LUBRICATING SYSTEMS"

by G. C. ALMASI, Materials and Standards Engineering Div., Crucible Steel Company of America, Midland, Pa.

G. C. ALMASI

▲ CENTRALIZED lubricating systems are considered today to be a necessary auxiliary to equipment for the making and shaping of steel. Even though the systems have been marketed for many years, there are still many operators and engineers who know little about them, except in a general way. The purpose of this paper is to set forth some basic rules to follow in the selection and design of centralized systems and their components.

The paper is based upon the author's 16 years' experience with lubricating systems from basic system repairman to lubrication engineer in modern steel plants.

The proper selection of lubricant transmission materials such as pipe, tubing, fittings, hose, etc., is discussed.

The selection of a pump depends upon many variables. Where and when to use certain types are discussed in the paper.

To properly select a type of feeder valve one must consider the operating conditions of the equipment to be served by the system. Some systems are superior to others under certain conditions.

Electrical controls, signal systems, and warning devices are also discussed. Finally the paper touches upon pumpability of greases and maintenance of systems.

The main thought of this paper is that many steel companies have systems which do not protect their bearings completely, and maintenance departments still have the ordinary bearing replacement problem and in addition have the systems themselves to maintain.

"AUTOMATIC CONTOUR TURNING OF LARGE MILL ROLLS"

by WILLIAM HYAMS, Manager of Machinery Sales, Mackintosh-Hemphill Div., E. W. Bliss Co., Pittsburgh, Pa.

WILLIAM HYAMS

▲ THE rapid expansion of the steel industry has placed a severe burden on steel plant roll shops. Rapidly increasing roll service requirements have stimulated development of the heavy-duty automatic roll contouring lathe, specifically designed for the preparation and redressing of large blooming and structural mill rolls.

This paper discusses some of the production and economic reasons behind the currently increasing use of these lathes and compares their performance and application with those of block lathes.

The first large lathe designed for automatic roll contouring went into service in 1952; since then, the writer's company has completed two more and is now building five additional units. In the years since 1952, many operating data and notes have been compiled, and are herewith presented.

The speed and power of the new lathes, coupled with the simplicity of their operation, enables them to outperform block lathes of equivalent capacity by ratios of 3:1 or more. In at least one case, these abilities have made it most profitable to use one of the new lathes almost entirely for roughing, notwithstanding the inherent accuracy of its contour-tracing apparatus. By using it thus and by completing machining of finishing rolls in block lathes, this roll shop has halved the total time on turning new rolls and redressing worn primary mill rolls.

It is the writer's conviction that these large automatic contouring roll lathes will see increasing use in the industry's roll shops and that changing production concepts and conditions will gain them widespread acceptance by both management and labor, who are already recognizing the fact that the supply of skilled roll turners is dwindling.

"SOME PRACTICAL SOLUTIONS TO HOT MILL PROBLEMS"

by R. A. SMITH, Assistant General Foreman, and A. D. PATTON, Assistant to General Foreman, 96-In. Hot Mill, Pittsburgh Works Div., Jones & Laughlin Steel Corp., Pittsburgh, Pa.

R. A. SMITH

A. D. PATTON

▲ PROBLEMS encountered in hot strip mills are many and vary depending upon mill conditions. This is not the only strip mill having problems; however, this 96-in. hot mill must be quite versatile due to the variety of commodities being produced and therefore problems are greatly multiplied. The following are some of the problems that will be discussed during presentation of the paper:

1. The increase of furnace production through changes to existing furnaces by means of minor alterations to furnace design.

2. Reduction of furnace outage time and the subsequent cost reduction through substitution of 3-in. double extra strength skid pipe in place of 2-in. extra strength skid pipe.

3. Increasing roll life by means of proper water distribution and increased water pressures.

4. Changes to runout table quenching spray system in order to meet metallurgical requirements when rolling heavy gage coil for line pipe.

5. Roll contours in relation to problems dealing with shape.

"APPLICATION OF STRETCH REDUCING OF TUBES—FOR GREATER PRODUCTION AND ECONOMY"

by WILLIAM RODDER, First Vice President, The Aetna-Standard Engineering Co., Pittsburgh, Pa.

WILLIAM RODDER

▲ THE process of simultaneously hot reducing diameter and wall of tubes in a number of roll stands without an inside mandrel is commonly known as stretch reducing. This is a comparatively new process and makes it possible to have large reductions in diameter without distortion of the tube wall and inside surface.

The maximum possible wall reduction is a function of reduction in diameter and the number of roll stands in use. Among the advantages of the process, when used in combination with electric weld mills, are increased production for smaller pipe sizes, reduced number of setups for cold forming mill and electric welds, and reduced number of required skelp sizes. For seamless tube mills, stretch reducing makes it possible to produce hot finished small diameter seamless tube in sizes from ½ to 1¼ in. It also gives greatly increased production for the smaller diameter sizes. In the case of larger sizes, the stretch reducing mill with a capacity of 7 in. outside diameter combined with a plug mill or mandrel type seamless mill simplifies rolling due to fewer size changes and fewer billet sizes which may be needed.

"LARGE MOTOR BEARINGS"

by WALTER T. SAVELAND, JR., Supervisory Engineer, Renewal Parts and Service, Motor and Generator Dept., Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

W. T. SAVELAND, JR.

▲ APPLICATION of electric drives to improve procedures and processes has placed progress in the iron and steel industry. Bearings play an important role in the service reliability of these electrical machines.

Bearing types vary in motors, depending on application requirements. Some are "fluid film" bearings, such as the sleeve type for radial loads, and the collar or shoe-type for thrust loads. Others are anti-friction bearings, such as ball or roller types.

Lubrication is necessary for successful bearing operation. Fluid-film bearings require lubricating oil to separate moving parts, and in some instances to float the rotating parts during starting. Oil or grease lubricant is needed to minimize wear in anti-friction types.

Design is another important aspect in bearing application. Performance of sleeve bearings depends on formation of an effective "oil wedge" between the rotating part and bearing surface. At the same time, provision must be made for keeping oil in the bearing enclosure and out of the machine's electric parts. Standard bearing design can be modified, too, for specific applications.

Auxiliary devices are available to give advance warning of bearing troubles. Every consideration is given to reducing or eliminating bearing maintenance.

"MAINTENANCE OF OIL FILM BEARINGS ON EUROPEAN MILLS"

by SAMUEL CARSON, Field Engineer, Morgan Construction Co., Worcester, Mass.

SAMUEL CARSON

▲ THE author recently spent three years in the British Isles and continental Europe working with operating mills to improve oil film bearing maintenance. In this time he visited mills in nearly every country in western Europe where all types of metals were being rolled on almost every type of mill. The foreign mills were able to benefit from American experience in most cases, but in addition they have developed some ideas that might well be copied in this country.

1. Permanently located cleaning tanks with adequate

crane service to make scheduled bearing inspections easier and less costly.

2. Facilities for drying bearing parts with clean, moisture-free air to eliminate the introduction of foreign matter from dirty rags.

3. Installation of a simple trap at the housing oil supply piping to catch a good deal of foreign matter from dirty piping which might cause bearing damage. Cleanout of the trap is easy and inexpensive.

A study of bearing maintenance areas shows that European mill managers consider their bearing shops should have 5500 sq ft per stand for large cold mills and 4000 sq ft per stand for large hot mills. These roll shops should be separate from, but adjacent to the mill proper.

"TEN PAINTING 'REMINDERS' FOR STEEL PLANTS"

by WALTER T. YARHOUSE, Industrial Sales Representative, The Sherwin-Williams Co., Cleveland, Ohio

W. T. YARHOUSE

▲ THE discussion of this subject favors the practical approach and considerations which have an every day influence on the decisions made by the men responsible for the maintenance painting in steel plants. It develops from interviews with a representative painting maintenance engineer, a maintenance supervisor, a general foreman of maintenance painting, a consultant, and a painting contractor who specialize in steel plant work.

In developing the subject, it is with reference to the published recommendations of the Steel Structures Painting Council and proceeds in the following continuity.

1. *Supervision*—Types, necessity and importance.
2. *Cleaning*—Methods, degree, necessity, importance and value.
3. *Painting conditions*—Atmospheric, temperature and seasonal.
4. *Thinning*—Control.
5. *Application*—Brushing, spraying and roller coating.
6. *Film thickness*—Control and importance.
7. *Specifications*—Formula, proprietary brand, performance and testing.
8. *Standardization and records*—Value and need.
9. *Buying of materials and services.*
10. *Color*—Desirability, necessity and value.

The "conclusion" includes comments regarding new types and formulations of paint products for specific purposes, as well as forecasts of expected future products based on present technical research and developments.

"STEEL INDUSTRY IN MEXICO—ITS PRESENT AND IMMEDIATE FUTURE"

by PASCUAL GUTIERREZ ROLDAN, Managing Director, Altos Hornos de Mexico, S.A., Mexico, D. F.

▲ THE Mexican steel industry started some 50 years ago when the first blast furnace was erected by the Monterrey Steel Works (Compañía Fundidora de Fierro y Acero de Monterrey), but remained more or less stagnant, reaching a peak production of 149,414 ingot metric tons in 1940.

P. G. ROLDAN

However, the real expansion of the steel industry began in 1941. A governmental credit institution—Nacional Financiera, S. A.—after making a careful survey of the national market, and finding out that iron ore, coking coal, and other raw materials were found in Mexico in quantities and qualities enough to guarantee a long time program of steel production and expansion, it was decided to start the construction of Altos Hornos de Mexico, S. A.

Since then the Mexican steel production has grown together with the national economy and industrial activity. In 1956 the steel ingot production reached a maximum of 865,022 metric tons, but still 629,000 tons had to be imported to cover the domestic demand. This means 48 kilograms or 106 lb per capita steel consumption, which is an increase of 250 per cent in 15 years.

Based on the rapid growth of the Mexican national income, which is the largest ever registered in the world, there is no doubt that the steel industry has a great future in front of it.

"EUROPEAN STEELMAKING TODAY—THE TECHNICAL AND ECONOMIC PICTURE"

by ALASTAIR McLEOD, Editorial Director-Technical, Industrial Newspapers, Ltd., Adelphi, London, England

ALASTAIR McLEOD

▲ THE tremendous upsurge in the demand for steel in Europe was foreseen prior to the war, but hostilities prevented any of the development plans being put into action. With the return of peace, and the advent of large-scale manufacturing and rebuilding programs, this demand even exceeded expectations, with the result that steelworks all over Europe swiftly acquired new plants, and demanded higher output—in quality and quantity—from equipment already in use. One development program has successfully followed another, with the result that the output of Western European steelworks rose (e.g. from 37,420,000 tons in 1937–38 to 58,620,000 tons in 1955)—an increase of 57 per cent. These figures, while showing a diminished percentage of total world production (30.9 down to 22.1) still indicate that the industry in the European area is very active in every branch of its activities—plant design and operation, process mechanization (or automation—to use the modern word) and metallurgical enterprise.

Development schemes have not always been easy to implement; the ideal green field site has been infrequently available, and with the over-all need to main-

tain production, considerable engineering skill had always to be available for installation work in plants continuously in production.

Recent years have been characterized by intense activity in all forms of research and development. The projects underway, which include such work as development in furnace fuels and the use of oxygen, the Kalling process, the L-D process and many others too numerous even to mention, make the present period one of the most important in the history of the industry.

Notable also in recent years has been the advent of the European Coal and Steel Community, linking France, Saar, Belgium, Germany, Italy, Luxembourg and Holland in these industries. The economic structure of this body and the general scope of its activities are discussed.

Advances in plant design, to produce not only the increased output that is continually in demand, but also to absorb the steady flow of research and development information are described.

"LIGHT FLICKER CAUSED BY ELECTRIC STEEL FURNACES"

by W. E. SCHWABE, Product and Process Development Laboratories, National Carbon Co., Div. of Union Carbide Corp., Niagara Falls, N. Y.

W. E. SCHWABE

▲ARTIFICIAL light sources such as incandescent light bulbs require a high degree of uniformity in the operating voltage. The human eye is capable of detecting minute variations of light emission especially when they occur in a cyclic sequence.

Some types of electrical equipment such as pumps, welding machines, and electric arc furnaces can, under certain circumstances, initiate short-timed voltage fluctuations and create a condition known as lighting flicker.

The problem of lighting flicker has been the subject of theoretical and experimental investigation during the past 20 years, and numerous papers have been published. In the course of this work, emphasis was put on corrective equipment for elimination or reduction of the disturbances. Furthermore, power companies established limits for the maximum tolerable voltage fluctuations in their networks based on cyclic reoccurrence of voltage dips at various frequencies.

During our research and development work on electric arc furnaces, we have investigated the behavior of the arc under various conditions of operation. It was found that the unsteadiness of arcs is the cause for the disturbances, and that it depends to an appreciable degree on the structure of the electrode tip. For this reason arc current fluctuations can be reduced as to magnitude and occurrence by using special electrodes which are characterized by an adequate structure at the tip.

After an analysis of the nature of the current swings, we found that there is no basic difference in the behavior of small and large furnace arcs. Their effect upon power networks is a matter of the ratio between furnace size and capacity of the power network.

In accordance with the findings reported in the literature, two different types of current swings are present at random: type A occurring at a rate of less than one per second, and type B occurring between three and eight per second, but with a lesser magnitude. They can be very pronounced at the beginning of meltdown, but they disappear gradually when the temperature of the melt increases.

It is very seldom that current swings occur in the abrupt manner of a square wave: either the upswing or the downswing or both are gradual.

This and the above mentioned random occurrence lead to a review of the existing standards of tolerable voltage fluctuations which presumably are obtained under square wave conditions. We found that tolerable voltage dips of approximately 0.7 to 0.8 per cent at a rate of four to seven per second can be accepted instead of the recommended 0.4 to 0.5 per cent. This is strengthened by the wide variation in the perceptibility of the human eye.

For demonstration purposes we built an apparatus which simulates disturbances created by arc furnaces and shows the effect on incandescent and fluorescent light bulbs. By way of contact camshafts and adjustable resistors and other electric parts, the effect of critical and non-critical phases of arc furnace operation upon light bulbs can be simulated and demonstrated. This machine can be a useful tool in predetermining and judging the degree of interference of newly planned furnaces with the power system.

"TRENDS IN INGOT BUGGY DESIGN"

by H. G. FROSTICK, General Supervisor Design Engineering (New Mills Construction), South Works, United States Steel Corp., Chicago, Ill.

H. G. FROSTICK

▲ THE ingot buggy is a materials carrying device operating at a crucial point in the steel shaping process. Its evolvement in handling a hot block of steel, weighing up to 100 tons, at the highest economical speed and through an area teeming with transportation hazards, has produced a design both functional and practical. Almost all ingot buggies are big and massive mechanically, and simple and elementary electrically. Yet, the trends point to an ultimate contrary to these common characteristics. As cable-driven buggies show some advantages over self-driven, the buggy is lightened by the weight of the driving motors and gears, and as the restrictions imposed by collector rails are removed, the driving and control schemes are made more complex. The wider usage of cable driven buggies has resulted in improved control schemes, usually variable voltage which makes feasible automatic spotting and regulated acceleration and stopping. Thus the buggies tend to become lighter physically, and probably faster, and more complex electrically, though perhaps, more reliable.

"BLAST FURNACE AUTOMATIC CHARGING CONTROL SYSTEM"

by S. P. CURTIS, Chief Engineer, Fairless Works, United States Steel Corp., Fairless Hills, Pa., R. F. SCHRAMM, Chief Electrical Engineer, Arthur G. McKee & Co., Cleveland, Ohio, and D. W. FATH, Senior Engineer, Cutler-Hammer, Inc., Milwaukee, Wis.

S. P. CURTIS

▲ THE automatic charging control recently placed in service on the new No. 3 blast furnace at United States Steel Corp.'s Fairless works provides greater flexibility in charging program selection and conveys more information to operating and maintenance personnel than has ever been done in the past. The complete system includes all control equipment in the hoist house, stock house and cast house, but this paper is devoted to the description of only certain features of the charging control panel and the operating and indicating panels.

The operating devices and indication in the stock house are arranged on two separate panels. All devices essential to the normal operation of the furnace are on a console located at the edge of the stock house platform. A short distance behind this console is a vertical panel including indication as well as switches for manual operation of the furnace charging. The indication on this panel shows the selected program and the actual progress of the steps in the charging cycle. This may be observed equally well from the scale car or the stock house platform.

R. F. SCHRAMM

The charging panel in the hoist house includes a program selection panel, program indication panel, and annunciator panel in addition to the motor-operated program switches and the control relays and contactors required for operation of the charging equipment. The control is designed to permit selection of a charging program of up to eighteen loads in a cycle. Selector switches are included to set up the charging sequence of ore, coke and stone, as well as the loads on which water is to be added and the points in the cycle at which the large bell is to dump and the distributor angle is to be changed. The flexibility provided becomes necessary as a greater variety of ores and sinter come into use.

D. W. FATH

The indication provided in the hoist house is a duplication of that in the stock house so any personnel in the hoist house will have complete information at a glance to facilitate servicing of the equipment. While a great deal of indication is provided, it is easy to focus attention to any particular item desired. This has been accomplished by the use of different colors and shapes of lenses, graphic representation and grouping of indication.

On the annunciator panel are fault finding devices to detect both momentary and maintained faults. Lights are also included on this panel which show the position of each of the motor-operated program switches thus providing individual check points on the progression of the program.

The motor operated program switches which control the charging cycle were designed specifically for programming service. Each has 18 positions and 24 circuits. The switches are mounted on the front of the panel and each is enclosed by means of a gasketed cover.

The control panels are sectionalized for ease of maintenance. All control circuits are 110 volts and color coding is used on all wiring to identify polarities and general circuit voltages.

The entire charging control system was designed to keep maintenance costs and time at a minimum and to maintain the high production rates required from the furnace.

"TRENDS IN STEEL MILL POWER PLANTS"

by HOWARD G. KITT, Senior Power Engineer, and ROBERT W. WORLEY, Chief Power Engineer, United Engineers & Constructors, Inc., Philadelphia, Pa.

H. G. KITT

▲ THIS paper points out the magnitude of power required for steel production, the necessity for steel mill power plants and their importance to the industry. It reviews the changes which have taken place over the past ten years and stresses the need for more efficient production and use of steam and electric power. The steps already taken by the industry toward this end are outlined as well as additional methods now being considered. Method for economic justification of more efficient equipment is given and probable future developments in steel mill power plants are expressed.

Steel production requires the equivalent of about three per cent of the installed electric utility generating capacity of the nation. Gradual changes in the use of by-product fuels have decreased their availability for power production resulting in a greater use of purchased fuel. The cost of purchased fuel requires efficient power plants to reduce the amount used.

R. W. WORLEY

Economic justification of improvements can be made based on purchased fuel costs. The load duration curve method is simple and graphic in demonstrating the electric and steam power requirements of a mill and their relation to available by-product fuels.

The steel industry has followed the general trend to larger steam generating units and higher pressures and temperatures for generation of by-product power from steam required for steel production. The increasing use of, and conversion to, 60-cycle equipment have per-

mitted ties with local utilities to supply power requirements over amounts economically generated in the steel mill plant.

Replacement of obsolete blast furnace blowing equipment and new construction with turboblowers of increasing capacity have reduced steam requirements. The use of blast furnace gas turbines for air blast is under consideration. Control and conservation of cooling water can result in reduced pumping power.

The trend is to higher initial steam pressures and temperatures, and larger capacity units of high efficiency as steel mills continue to increase in size. The use of steam at 1250-psig and 975 to 1000 F should not be unusual within a short time. Equipment and procedures now used by the utility industry for improved efficiency will come into common use in steel mill power plants.

"GAS STORAGE FOR PEAK DEMANDS"

by ROBERT KYLE, Vice President, The Gas Machinery Co., Cleveland, Ohio

ROBERT KYLE

▲ GAS holders probably constitute the first thing that one thinks of when the problem of gas storage occurs. There are various types of gas holders available which are later described and also alternate means of effecting gas storage.

Low pressure holders—These offer a conventional storage means for gas both from the history of the gas industry and in the steel industry. The wet seal holder is the most common type, a telescopic arrangement utilizing holder "cups." Water is the usual sealing medium being contained in a large cylindrical tank from which water is picked up by the cups of the various holder sections. Storage volumes may be 1000 to 15,000,000 cu ft. Holder pressure is normally 5 to 14 in. water column, but can be increased approximately to 25 in. by weighting of the holder lifts.

Dry seal holders are of somewhat more recent origin. There are two variations; the piston type and the diaphragm type. The practical volume for the diaphragm type ranges from about 10,000 to about 1,000,000 cu ft. Piston type holders are seldom built for less than 200,000 cu ft with a possible maximum of 15,000,000 cu ft.

Low pressure holders in general, were formerly riveted and are now built in welded steel construction. The paper contains illustrations showing construction of low pressure holders together with charts and curves for the cost of various sizes.

Pressure holders—These are particularly applicable where gas is distributed at some moderate pressure higher than could be obtained at the outlet of a low pressure holder storage without compression. The total capacity in these applications is likely to be under 1,000,000 cu ft referring to standard conditions. The usable capacity is determined by the range of pressure from maximum storage pressure to delivery pressure. The practical maximum pressure depends on the volume of each individual storage vessel and is limited to approximately 1¼ in. plate. Under these conditions, large volume pressure holders may have a maximum storage pressure of 40 psig, smaller volume vessels can operate up to 100 psig. The paper includes illustrations of pressure storage holders with charts showing costs for various capacities.

Storage as liquid—A number of gases can readily be stored in liquid form—later released as gases or vaporized. Examples are propane, butane, and ammonia. The most likely fuel gas in this category is propane which is usually stored in horizontal tanks with typical capacities of 30,000 and 18,000 gallons water capacity. Net propane liquid will be about 85 per cent of the tank water capacity. Propane storage tanks may, of course, be built in smaller sizes and may even be made as small as 10 gallons each for portability.

Newer storage methods are being offered for large volume storage of propane. One of these involves refrigeration with storage at comparatively low pressure. Another and larger volume method recently employed, is the use of underground caverns, which caverns are man made.

The paper also briefly discusses auxiliary gas generation as a means of supplying standby gas.

"NEW COMBUSTION PROCESS FOR TEMPERATURE UNIFORMITY IN HEAT TREATING FURNACES"

by F. C. T. DANIELS, Consultant, and STEVE STASKO, Assistant Chief Metallurgist, Mackintosh-Hemphill Div., E. W. Bliss Co., Pittsburgh, Pa.

F. C. T. DANIELS

▲ THE new combustion process combines simplicity and flexibility to achieve improved temperature uniformity and control in the temperature range of 200 to 2300 F. Two end firing burners replace multiple side firing burners and a furnace atmosphere control permits adjustment of fuel and air to any desired ratio at a single location. Prior to the adoption of the new process, tests were conducted to compare the temperature uniformity in side-fired and end-fired furnaces. Test blocks were placed at the top and bottom of each furnace with thermocouples attached. The maximum temperature of the heat treating cycle in both cases was 950 F. The average temperature difference, top to bottom of the furnace, was 84.6 F in one of the side-fired furnaces. The maximum difference at any one time was 140 F. A furnace equipped with two end firing burners showed an average temperature difference of 8.7 F. The maximum difference at any one time was 20 F.

STEVE STASKO

The new combustion process is equally successful in pit, car, or cover type furnaces. It has also been used in foundry mold drying operations where the ovens are much higher in evaluation, but still re-

quire uniform temperatures top to bottom. The system is particularly desirable for use in heating large articles such as cast steel rolls and highly alloyed, very hard cast iron rolls which in their heating and cooling demand slow, uniform rates.

"SAFEGUARDING STEEL PRODUCTION"

by R. M. L. RUSSELL, Assistant Chief Engineer, Factory Insurance Association, Hartford, Conn.

R. M. L. RUSSELL

▲ STEEL might well be called America's lifeline to survival in a world being torn asunder by political and economic strife.

Any instrumentality cutting this lifeline, interrupting steel production, from within our shores, is as great a threat to existence as a free people as though such disaster came upon us from a foreign shore.

Fire (or explosion) is one of the most widespread and powerfully destructive perils which today, as in the past, overshadows American industry—and steel is no exception.

Reduced to the simplest terms, the steel industry can meet and overcome, to a large degree, the fire peril by taking the following steps:

1. Assuring that a new plant site has an inexhaustible unfailing water supply available, adequate for maximum service and fire protection needs.

2. Selecting construction materials that are noncombustible or fire resistive. If for reasons of economy and durability, coated metals are used for building roofing or siding, those types which have been tested and listed by the Underwriters' Laboratories as having very low flame spread (noncombustible rating) should be used in areas not requiring sprinklers. Where an occupancy requires sprinkler protection, a wider selection of construction materials may be made.

3. Assuring that all important electrical transmission and distribution lines are completely protected, not only from lightning and overloading by suitable protective gear, but also sufficiently clear of all facilities that might bring about a power outage resulting from mechanical injury.

4. Following prescribed safe methods for the storage, distribution and handling of all types of fuel, including the compacting and frequent temperature checking of coal piles, the safeguarding of fuel oil by using properly equipped and diked well segregated storage tanks, and the safe arranging of all fuel gas piping well protected with easily accessible emergency shutoff valves.

5. Equipping furnaces and other preheating equipment with adequate and well chosen protective devices intended to prevent the accumulation and subsequent ignition of any unburned fuel gas accumulation. Comparable protective devices should also be provided where other fuels such as oil or L.P. gas are used.

6. Properly equipped rolling mills and oil cellars with automatic fixed fire extinguishing equipment selected to quickly extinguish a fire involving lubricant and coolant oils without undue damage to process equipment or the coolant medium.

7. Properly protecting high valued all-important bottle-neck rotating machinery such as found in mill motor rooms with automatic fixed fire extinguishing equipment. In this connection, all combustibles that might initiate or sustain a fire in such electrical rooms should be kept out of such areas.

8. In by-products production and storage areas, all safeguards normally called for in the handling of flammable liquids, including the use of fixed and portable fire fighting equipment, explosion proof electrical equipment, mechanical ventilation, grounding and good housekeeping should be incorporated.

9. Finally, a well organized, well trained and adequately staffed properly equipped private fire department should be maintained as well as a thorough frequent and regular self-inspection program with an effective follow-up system for properly correcting deficiencies that come to light.

"SOME HEAVY INDUSTRIAL NOISE PROBLEMS, THEIR ANALYSES AND SOLUTIONS"

by RICHARD D. LEMMERMAN, Manager, and RICHARD R. AUDETTE, Assistant Chief Engineer, Industrial Sound Control Dept., Koppers Co., Inc., Baltimore, Md.

R. D. LEMMERMAN

▲ THE problem in industrial noise, which has arisen seemingly only recently to plague both management and the safety engineering personnel, is in reality not a new one. Rather, instead, the cognizance of noise as a major industrial problem is new. Increased economic pressures through the new proximity of residential areas in the case of the residential noise problem and the results of ear damage compensation claims, together with union demands for improved working environments, have spurred more recent interest in the noise problem.

The aircraft engine industry has been plagued with serious noise problems for two decades and other industries with increased interest in the noise problem are beginning to move along the same path followed by the aircraft.

R. R. AUDETTE

Similarly, the basic engineering approaches to industrial noise problems are relatively new, developed by the demands of the aviation industry. Instrumentation and measurement techniques, together with basic information as to how people react to noise environmentally, have made substantial strides in the last few years, thus allowing noise control to move from the realm of theoretical physics to that of a true engineering science.

This paper examines noise in the framework of its effect upon people and discuss several solutions to industrial noise problems through the analysis of typical case histories of industrial noise problems.

"SUMMARY OF OPERATING RESULTS WITH OXYGEN"

by J. H. STRASSBURGER, Assistant Vice President, National Steel Corp., Pittsburgh, Pa.

J. H. STRASSBURGER

▲ DURING the last 12 years the use of oxygen in iron and steelmaking has increased to such a marked degree that we might term the oxygen iron and steelmaking practices as being one of the outstanding contributions to increased iron and steel production during the past decade. All of this development work has started from approximately the year 1946 at which time oxygen was introduced in the open hearth furnaces for accelerated combustion by the use of oxygen through the burner and also for the decarburization of the open hearth heat by lancing oxygen into the bath of the furnace. In addition to the use of oxygen in the open hearth furnace, the lancing practice was closely followed by the electric furnace plants so that this practice is also used in a great many electric furnaces today for shaping up the heats, decarburizing and speeding up electric furnace steel production.

As an outgrowth of the oxygen converter, the development of oxygen lancing through the roof of an open hearth furnace has now been developed by several steel plants for increasing open hearth production. Jetting of oxygen on the open hearth bath speeds up the heat not only by carbon reduction, but also by accelerating the melting of scrap and the shaping of the heat. Up to 500 cu ft of oxygen are used per ton of ingots with this lancing operation.

After the initial trials with oxygen and open hearth furnaces, oxygen was then experimentally used for enriching the blast of bessemer convertors in order to speed up the blowing of iron and also for the melting of additional scrap. This practice is being followed today by several plants as a means of increasing bessemer convertor production. In the late 1940's and early 1950's the development of the top blown oxygen convertor in Austria was one of the outstanding contributions in the form of a new steelmaking process with the entire heat for the production of steel supplied by the oxygen reacting with the molten metal bath. The use of oxygen for the conversion of iron to steel has also been given impetus by work in both Sweden and in Germany, where other types of oxygen furnaces are under development at the present time. Also in Europe it is practically common practice today for all of the bottom blown Thomas convertors to enrich the blast with up to 28 to 30 per cent oxygen in order to obtain not only faster heats but also a better quality of steel by reducing the nitrogen content of the steel due to the oxygen in the blast. In surveying the European Thomas convertor plants in Germany, Belgium, Luxembourg, France, England and Sweden, we find that it is most common to find an oxygen plant of 100 to 200 tons daily capacity for supplying oxygen to the convertor operations.

The use of oxygen in blast furnaces for increasing iron production has also been a development during the past decade. Enrichment of the blast for blast furnace operation was started by the Weirton Steel Company Division of National Steel Corporation in 1951. After 6½ years of operation, with oxygen used from 1 up to 4 per cent enrichment, we have found that the use of oxygen in the blast of a blast furnace has resulted in increased iron production and smoother working furnaces. At the present time, a ferromanganese furnace operation is now on oxygen enrichment and we understand showing quite satisfactory results in both increased ferromanganese production and a marked decrease in coke rate.

In summarizing the use of oxygen in the various steelmaking operations, the following is a rough estimate of the quantities now being used in the various operations:

Open hearth lancing	150 to 300 cu ft per ton of ingots
Open hearth jets through the roof	100 to 500 cu ft per ton of ingots
Open hearth combustion	125 to 500 cu ft per ton of ingots
Bessemer convertor	400 to 500 cu ft of oxygen is required per ton of convertor production
Top blown oxygen convertors	1800 to 2200 cu ft per ton of ingots
Hot scarfers	100 to 150 cu ft per ton of slabs
Blast furnaces	1200 to 4500 cu ft per ton of pig iron at 1 to 4 per cent enrichment

As can readily be seen all of the above practices in using oxygen add up to a tremendous increase in the use of oxygen in iron and steelmaking. When it is considered that this development has practically all taken place within the past 11 to 12 years, it is our opinion that the use of oxygen will continue to increase beyond the practices of the present time with further increases in iron and steel production.

"TREATMENT OF WATER-BORNE WASTES FROM STEEL PLANTS"

by ROSS NEBOLSINE, President, Hydrotechnic Corp., New York, N. Y.

ROSS NEBOLSINE

▲ THE principal water-borne wastes from integrated steel plants consist of flue dust, mill scale, floating and soluble oils, acids and phenols. These represent approximately 8,000,000 tons of waste materials per annum mixed with, and carried by, roughly a thousand times that amount of water.

Granulated cinder is in a different category and is considered separately. Miscellaneous ferroalloy and plating wastes, caustics, cyanides, palm oils, etc., are not covered in the paper.

Much work has already been accomplished by the steel industry in the control of pollution. At many plants, installations are intercepting up to 90 or 95 per

cent of these wastes. However, at only a very few plants are the facilities adequate to do this consistently, that is, without having at times to by-pass the treatment installations and thereby discharging dirty effluents into the water body.

Meeting the anti-pollution criteria currently being established in many states, which require complete and steady treatment, will necessitate a new approach to the design of such facilities. It will not be sufficient to obtain adequate results with those waste bearing effluents that are fed to equipment units whilst the latter are operating. The discharges must be cleaned up continuously, which means having to provide reserve, or standby, capacity. Increased steel production rates must be anticipated and this will usually mean larger discharges of wastes. Even when suitable treatment processes are available, the most difficult phase of each project will be how all such improvements can be physically fitted into already congested steel making installations.

The paper discusses, with respect to each of the seven principal waste materials, the discharge volumes, concentrations and the significant characteristics of each of these substances. Present treatment methods and equipment, and the improved processes and layouts, which are being developed, are outlined. Finally, a brief review is included of the cost factors and the probable economic burden to the industry that more complete treatment will involve.

"BENEFITS OF PURCHASED OXYGEN TO THE INDIANA HARBOR WORKS OF THE INLAND STEEL COMPANY"

by N. R. KIRKDOFFER, Superintendent, Power Steam and Combustion Depts., Inland Steel Co., East Chicago, Ind.

N. R. KIRKDOFFER

▲ INLAND purchases all its oxygen requirements through three systems of supply: low purity and high purity come through pipelines from a nearby plant owned and operated by a supplier, and oxygen for scrap preparation is delivered. Oxygen requirements for open hearth combustion and decarburization were determined by planned use of oxygen by means of a liquid oxygen storage and gasification unit installed on Inland property. Benefits of increased use of oxygen have confirmed pilot test results.

The paper describes the oxygen distribution systems at Inland and gives a brief history of the growth in oxygen requirements and how these requirements were supplied. Inland made a thorough study of the oxygen supply problem in regard to purchasing of oxygen versus purchasing of oxygen generators.

Experience for nearly five years has produced data that will show the effect of load variation on the economics of oxygen supply and continuity of operations. The paper concludes with a resume of the future of oxygen use and possible methods of obtaining the expected increase in oxygen requirements.

"ECONOMICS OF GENERATED VERSUS PURCHASED OXYGEN FOR STEEL PLANT USE"

by R. A. LAMBERT, Superintendent, Steam Efficiency and Combustion Dept., Pittsburgh Works Div., Jones & Laughlin Steel Corp., Pittsburgh, Pa.

R. A. LAMBERT

▲ THIS paper discusses the economics of plant site generated high purity oxygen versus purchased oxygen. The Pittsburgh Works Division of Jones & Laughlin is a fully integrated steel plant. The total oxygen requirements at 100 per cent operating rate average upwards from 75,000,000 cu ft per month. This is based on oxygen use for decarburization purposes on 21 open hearth furnaces and for mechanical billet scarfing and mechanical slab scarfing. In addition to these major consumers, there is an appreciable amount used for miscellaneous burning and welding throughout the plant. A plant detailed distribution and consumption is included in the paper.

Oxygen transmission lines are used extensively throughout 95 per cent of the plant area. Five main distribution lines leave the oxygen generating plant. One 8-in. line supplies the mechanical slab scarfer only. Another 8-in. line supplies the No. 4 open hearth shop consisting of eleven 275-net ton furnaces for decarburization purposes only. A 3-in. oxygen line extends across the interplant bridge over the Monongahela River to supply all the North Side plant requirements. Very little bottled oxygen is used.

Four 25-ton per day capacity oxygen units comprise the present generating plant with space provision for two additional units. A 1,000,000-cu ft capacity reserve storage for gaseous oxygen is also included. The generating and distribution systems are well metered. The various items entering into the cost of generation and oxygen plant maintenance are included in the discussion. Illustrations also include the cost variation for varying levels of plant operation. Methods of consumption control are included in the discussion.

"OXYGEN PLANT CYCLES TAILORED TO THE REQUIREMENTS OF IRON AND STEEL PRODUCERS"

by CLARENCE J. SCHILLING, Vice President and Chief Engineer, Air Products, Inc., Allentown, Pa.

C. J. SCHILLING

▲ THE paper concerns itself essentially with the principles involved in four types of air separation cycles as used for the iron and steel industry.

The rectification apparatus in each case is a two pressure distillation column. However, the auxiliary equipment, namely: air compressors, scrubbers, driers, heat exchangers, etc., are in each case adapted to the particular cycle employed.

1. The low pressure cycle as used to produce large quantities of 95 per cent oxygen at 2-psig is analyzed in relation to a typical application, namely: wind enrichment to a blast furnace.

2. The medium pressure cycle is distinguished by the incorporation of a liquid oxygen pump, oxygen storage bank and a 99.5 per cent oxygen purity. This cycle is the one most frequently employed for critical oxygen requirements.

3. The high pressure cycle is characterized by the use of compressed air at 2000 to 3000 psi and the production of all the oxygen as a liquid. Refrigeration is supplied by a reciprocating expansion engine.

4. The mixed pressure cycle is characterized by the use of compressed air at two pressures. Oxygen is normally produced at 99.5 per cent purity. Liquid oxygen pumps are employed and oxygen storage (gas and/or liquid) is provided.

It is a combination of the low pressure cycle and high or medium pressure cycle and is extremely flexible in application while producing oxygen at low cost.

A typical use is for the top-blown Bessemer converter. The equipment required to produce 230 tons per day of 99.5 per cent oxygen is described.

5. Power cost of oxygen per ton is related to storage pressure as well as cycle employed.

"OPERATION AND MAINTENANCE OF A 100-TON DOUBLE CYCLE, GASEOUS OXYGEN PLANT"

by G. T. WRIGHT, Mechanical Superintendent, Dominion Foundries and Steel, Ltd., Hamilton, Ontario, Canada

G. T. WRIGHT

▲ THIS paper describes the flow sheet of the plant giving temperatures, pressures, and volumes at the compressors, regenerators and the high and low pressure columns. Maintenance of the rotating equipment is described as well as two examples of maintenance inside the cold box.

"PRACTICAL ASPECTS OF POWER LAYOUTS FOR STEEL MILLS"

by A. J. MOSSO, Vice President, Auburn & Associates, Inc., Pittsburgh, Pa.

A. J. MOSSO

▲ THIS paper covers the practical problems involved in making power layouts for steel mills. It develops the practical aspects involved in the physical arrangement of electrical equipment and the approach to the problem of making installation layouts required for field erection of both the equipment and the interconnecting ducts, conduit, cable, wire and bus.

It begins with a general discussion of loads involved in an integrated steel mill. This part of the paper discusses the high voltage distribution systems used in large and small mills and the advantages of the methods normally utilized.

This is followed with a discussion taking a mill layout from its beginning to the completed job. Motor room layouts, conduit and cable schedules, grounding, conduit and bus layouts, ventilation in motor rooms and interconnection diagrams are covered.

Practical suggestions to permit quick estimates of ventilation requirements, motor room layouts, etc., are discussed. Many mills have power bus in motor room which would not withstand fault stresses. With emphasis on d-c bus which is most commonly used in the metal working industry, the paper explains the relatively simple calculations involved in good bus design.

Various trends in the utilization of products on the market to make mill layouts along with advantages of each are briefly covered.

The paper is written in the logical sequence which is used in making power layouts. To completely cover all phases of a power layout which would normally require 200 to 1000 drawings even for a modest mill is, of course, impossible. The author however covers the important highlights and warns of the pitfalls that could occur. The contents of the paper would be of primary interest to the electrical engineer whose duties involve the electrical design of new facilities or the revamping of old ones.

"RECENT HOT STRIP MILL ROUGHING TRAINS"

by JOHN H. GREINER, Application Engineer, Electrical Application Dept., Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

J. H. GREINER

▲ THIS paper gives a brief electrical description of typical hot strip mill roughing trains that were installed in the thirties and continues with three mills installed in the fifties. Mill widths are 98 in., 86 in. and 80 in. with broadside stands included on each mill.

The paper deals with types of motors that may be used, horsepower, number of gear reductions, electrical and mechanical inching equipment, dynamic braking schemes and typical ventilating schemes.

"CONSTANT HORSEPOWER COMPUTER—PERMITTING THE USE OF SLIP COUPLINGS FOR WINDER DRIVES"

by P. R. GRAVENSTRETER, Electrical Engineer, The Clark Controller Co., Cleveland, Ohio

P. R. GRAVENSTRETER

▲ THE paper demonstrates how a well known device may be employed as a computer—to develop an electrical output proportional to the product of speed and torque. An application of this device is described showing the computer in the tension reeling of strip.

A number of small metal rolling mills are now in production using this principle, with the support of electrically controlled slip couplings and induction type a-c drive motors.

TREATMENT

By
GRANT A. PETTIT
Industrial Waste Control Engineer
Armco Steel Corp.
Middletown, Ohio

▲ ARMCO Steel Corporation, at its Middletown, Ohio plant, recently completed the final step of its program in the treatment of mill scale wastes from the continuous strip mill, to conserve water and abate pollution to the Miami River. This is an 80-in. mill, and consists of three 2-high roughing mills, two 4-high roughing mills, four vertical edgers, and six 4-high finishing mills. This program was carried out in two steps over several years, and these steps will be described separately in order as they were installed and operated.

In discussing rolling mill scale wastes, we are concerned with the sedimentation of the iron oxide scales and the removal of certain oils and greases carried along with these waste waters. The characteristics of these wastes will vary as to suspended solids, oil and temperature, according to which mill or set of mills is being considered. In addition, the suspended solids will vary as to particle size, particle shape, and percentage of fine to large particles. These variables are a function of the kind, grade, and gage of steel being rolled.

As with most rolling mills, conventional scale pits were installed with the first mill installation. These pits were the straight flow-through type, wastes coming in one side and overflowing to the sewer from the opposite side. A certain amount of depth was reserved for settled scale which was removed with a clamshell bucket. With the several increases in production, enlargements of the mill, etc., the interval between the necessary times for cleaning became less and less until it was impossible to keep them operating efficiently. Therefore, considerable scale carried through into the plant sewers, and there was a continual sewer cleaning job, with all its inherent difficulties.

A very complete survey of these waste flows, made over a period of several months, indicated that the scale removal efficiency of the four pits taking the wastes from the roughing and finishing stands was very erratic. The efficiency ranged from very good for a short period after cleaning to very poor as the pits filled with scale, with a low over-all efficiency. The study also showed that the wastes from the roughing stands and 1000-psi spray ahead of the finishing stands would lend themselves to gravity separation, whereas the suspended solids content of the wastes from the finishing stands was so fine that gravity separation was not practical.

Therefore, as step one in the program it was decided to first treat only the waste waters from the roughing stands and the 1000-psi sprays ahead of the finishing stands. In order to assure continuous high efficiency of scale removal, a sedimentation basin with mechanical collectors for the removal of scale was considered. After considerable testing and study, Armco engineers designed the equipment for the treatment of these wastes. The following brief description covers the collection channels, sedimentation basin, scale and oil removal equipment.

DESCRIPTION OF FACILITIES

Collecting system—Open collection channels, varying in depth from 5 to 12 ft, collect the waste waters from the roughing mills and the 1000-psi spray ahead of the finishing strands. Based on flows, tributary slopes and cross section areas were selected to provide velocities sufficient to keep the various sized scales in motion. These velocities vary from 6.8 to 7.5 ft per sec at entrance to the sedimentation basin. The various collection channels converge into a single channel, a short distance from the basin. From this section, two channels of like cross section and slope diverge and discharge into the distribution trough extending across the influent end of the basins. The floors of these inlet channels extend across the distribution trough, so by means of stop gates, flows may be regulated and any pair of two chambers of the basin may be used at a time.

Sedimentation basin—The sedimentation basin (Figure 1) is made up of three parallel chambers, the design of each chamber being based on a flow of 3000 gpm. Originally, the design was for two-chamber operation, with third chamber as standby in case of mechanical failure.

Each chamber has inside dimensions of 10 ft x 67 ft 10 in. (effective) x 8 ft 6 in. water depth and represents a capacity of approximately 5230 cu ft or 39,200 gal. On the basis of complete displacement and design flow of 3000 gpm the velocity through the chambers is 4.7 fpm the area overflow rate being approximately 6400 gal per day per sq ft.

The overall depth of the basin is 21 ft, due to ground elevation and the necessity of fixing elevation for the gravity collection of the water wastes.

The inlet channels enter a distribution trough which extends across the influent end of the battery of three chambers. By means of stop gates, any pair of two chambers may be used at a time with one entirely out of service. The downstream wall of the distribution trough extends to a depth of 4 ft below the flow line. The upstream wall of this trough is sloped to give a one-ft opening at the bottom. A downward underflow is obtained to provide for stilling and distribution of the flow.

The effluent flows under an effluent baffle and over a weir extending across the outlet ends into a common effluent channel, and then to a channel connected to the mill sewer. An oil skimming pipe is provided across the three chambers ahead of the effluent baffle.

Straight-line collectors designed to travel at 2.5 fpm were installed for scale collection, dewatering and removal. The equipment was designed for underwater return, and does not function in oil removal.

AND RE-USE OF MILL SCALE WASTES
to Conserve Water and Abate Pollution

. . . . the new waste treatment system at Armco's Middletown plant has helped solve the problem of obtaining sufficient water for mill operation . . . in addition, the system has been of great value in solving the stream pollution problem . . . .

Each collector consists of two parallel strands of combination promal and steel chain, with channel steel flights at 4-ft intervals. Hardened steel wear plates are provided on the flights. At the inlet end of the chambers the collectors travel up a steel-lined 45-degree incline to a point 14 ft above the tank walls (Figure 2). Scale is delivered to three hoppers, one for each chamber. The scale drops from the hoppers to a flat horizontal belt conveyor running across the end of the chambers. This conveyor discharges the mill scale into the loading hopper of an inclined, pivoted belt conveyor which delivers it to railroad cars (Figure 3).

A hand operated oil skimmer is provided at the effluent end of the chamber to remove oil from the surface to an outside oil sump. It is then pumped to a large oil storage tank above the exit end of the chambers.

Operation—This sedimentation basin was in operation as originally designed for approximately three years, and proved to be a very efficient installation for the removal of mill scales, oil, and grease from these wastes. It was operated at flows from 3300 to 4700 gpm, with the monthly average being approximately 4200 gpm. Influent suspended solids varied from 2800 to 3500 ppm with monthly average of approximately 3200 ppm. With these variations, the average effluent remained consistently between 40 to 60 ppm, suspended solids, 3 to 7 ppm iron, and 14 to 20 ppm oil. The suspended solid value runs higher when the river water entering the plant is very high in suspended matter due to storm run-off. The average suspended solids of the river water entering the system is 103 ppm. From 130,000 to 155,000 lb per day of scale was removed from the basin, with the average being approximately 145,000 lb per day. The scales

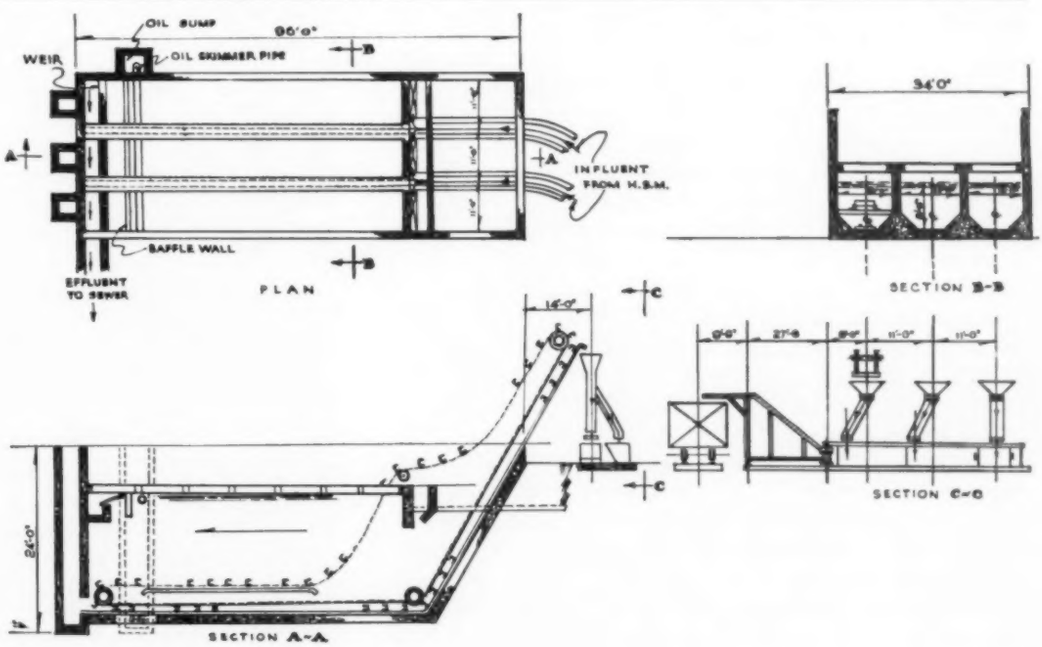


Figure 1 — Three parallel chambers make up sedimentation basin.

Figure 2 — Three conveyors move material from sedimentation basin.

removed contain approximately 70 per cent iron oxide, with a moisture content of 30 per cent. The monthly average figures for a normal month were as given in Table I.

TABLE I

Operating Data—Monthly Averages—Sedimentation Basin Armco Steel Corp., Middleown, Ohio

Suspended solids influent, ppm	Suspended solids effluent, ppm	Oil in effluent, ppm	Flow, gpm	Lb suspended solids per day
3125	46	16	4088	149,000

Very little difficulty was experienced in operating this equipment. It should be mentioned that rates of flow in the collecting system have been high enough to prevent any settlement of scale in this system without undue erosion. Maintenance has been at a minimum, the only major maintenance work during this period being to turn over the wear plates on the collectors.

During the first several months of operation, several minor changes and improvements were made that are worth mentioning. Although we were successful in diverting equal volumes into any two chambers, we were not as successful in the diversion of the solids. It was found that more solids were entering one chamber regardless of which combination of two chambers was used. We therefore speeded up the collectors to operate at 5 fpm in No. 1 chamber, 3¾ fpm in No. 2 chamber, and 2½ fpm in No. 3 chamber. This has proved very satisfactory.

It was also found that a portion of the heavy scales dropped out directly below the distribution trough and were imbedding the sprockets on the inlet end. Steel plates were installed to divert the scale away from the sprockets and to the center of the flights.

This brief discussion covers the first step installation and operation of these facilities to treat the mill scale wastes from the roughing stands. No attempt was made to re-use the clarified effluent from this installation. As stated above, the sedimentation of the very fine scales from the finishing mill wastes is beyond the realm of gravity separation alone. The addition of chemical coagulants is required to aid the separation. The urgency for treatment of these very fine scale laden wastes and the degree of treatment required will vary from mill to mill. This variation may be due to state regulations (present and future) or to various water supply problems particular to an individual mill, or a combination of both.

In the case of our Butler, Pa. plant, we are located on a very small stream, and are required by the Pennsylvania State Water Board to furnish complete treatment for all wastes leaving the plant. At the Middletown plant we are located on the Miami River, so the problem of complete treatment of these wastes is not as urgent, but certainly one that will require our attention before too long. The added problem at Middletown was one of water supply. Because of the deficiency of rainfall during the drought years of late 1952 through 1954, plus the fact that we were increasing use of well water, the water table in the area was dropping at an alarming rate. We were faced with a real problem as to well water needed for the processing units. It can also be said that the Miami River looked none too healthy during this period. Therefore, it was decided to institute the second step in the program, that is, the complete treatment of all mill scale wastes from the roughing and finishing mills and the re-use of the clarified water.

A preliminary study of the problems presented in treating the very fine scale wastes from the finishing

Figure 3 — Mill scale is discharged into a hopper.

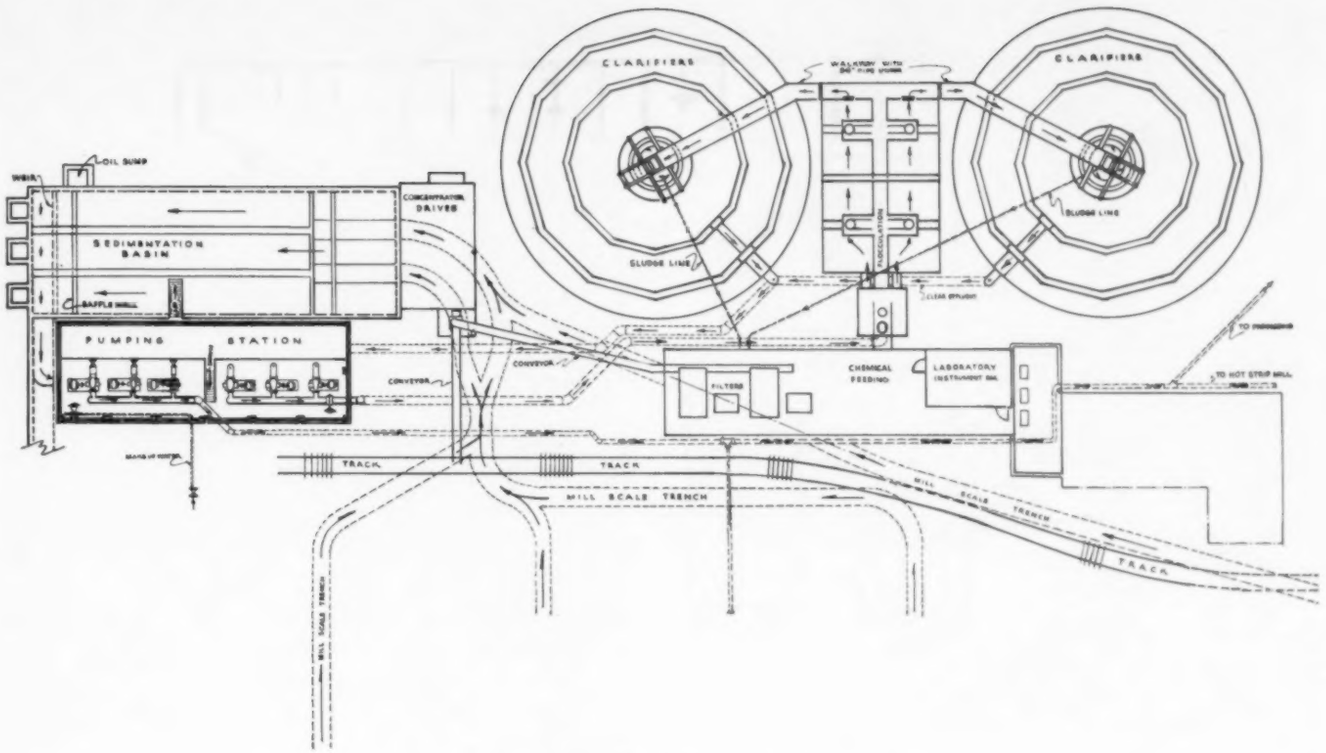


Figure 4 — Final layout is shown in this plan.

stands led to a very complete pilot plant setup being made at the Butler plant. Here, over a period of 2½ years, pilot plant work was carried on using various coagulants and different types of equipment. It was possible to determine the best chemical coagulants, their dosage and pH requirements for best flocculation, types of flocculation and clarification equipment required, means of sludge disposal and all necessary design data for treating this type of wastes. This information served as the basis for the design of the following equipment for the complete treatment of the roughing and finishing mill wastes at Middletown.

ADDITIONAL FACILITIES FOR COMPLETE TREATMENT

Collecting system—Additional collecting channels were added to the sedimentation basin system to collect the additional flow from the finishing stands. See Figure 4.

Sedimentation basin—The sedimentation basin remains the same, but all three chambers are now used to take care of the increased flow.

Pumping station—A pumping station was installed adjacent to the sedimentation basin. Two rectangular wells are located under this station. One well 15 x 75 x 10 ft deep serves as a collection sump for the sedimentation basin effluent. The other well 7 ft 8 in. x 75 ft x 20 ft deep collects the clarified water for re-use. Three 6000-gpm, 60-ft head pumps (two in use, one standby) are used to pump the sedimentation basin effluent to the mixing chamber ahead of the clarifiers. Three 6000-gpm, 150-ft head pumps (two in use, one standby) are used to pump the clarified waters to the distribution systems of the mills and processing units. Float control valves maintain the levels in the wells and a butterfly control valve is located in the line to the mixer to control pumping to the clarifiers in accord with the demand.

Mix tank—A simple quick mix tank 12 ft 6 in. square, 15 ft water depth, 1.5-min retention, with variable high speed mixer, serves to mix the chemicals with the waste waters.

Flocculation—Two flocculation tanks 15 x 45 x 15 ft water depth, 12.5-min retention, with two variable low speed mixers in each tank, serve to flocculate the suspended matter in these wastes.

Clarification—36-in. pipes allow gravity flow from the flocculators to the center wells of two 80 ft diam, 15-ft side water depth, 18-ft center depth clarifiers. The clarifiers have 18-ft diam center wells with inlet diffusion troughs. Retention time in the clarifiers is approximately 123 min, rise rate is 1.25 gpm per sq ft, at 12000-gpm total flow. Weir troughs on 43 and 70 ft diameters collect the clarified overflow for return to the clear well at the pumping station. Sludge scraper collectors driven by one-hp motor scrape the sludge to the center annular sumps for pumping to the filter decanting ranks.

Chemical building—This building is adjacent to the clarifiers, with the second or working floor slightly higher than the top of the clarifiers to allow gravity flow of chemicals to the mix tank. The first floor of this building houses the sludge decanting tanks, electric substation, and serves as storage for chemicals. On the second floor are located duplicate lime feeders and slackers, lime solution feeder, duplicate coagulant feeders, complete chemical control laboratory and operating control panel, two 100-sq ft vacuum filters, and filter cake conveyors. Chemicals are conveyed from the first floor to the storage hoppers above the chemical feeders by means of bucket elevators.

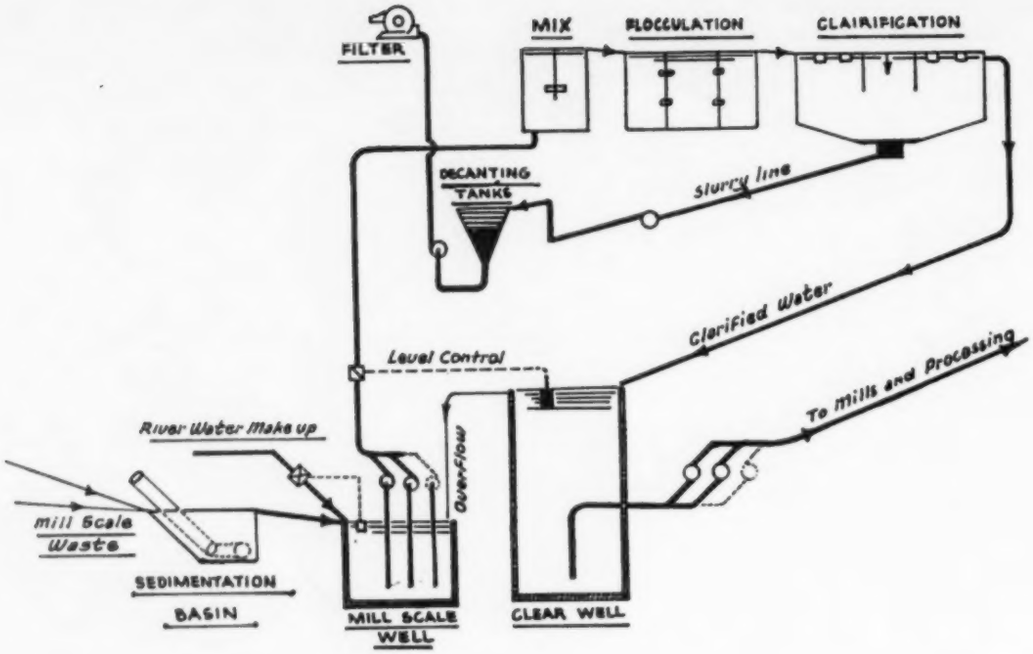


Figure 5 — Flow sheet shows operation of clarification system.

OPERATION OF THE COMPLETE SYSTEM

As this system now operates, (Figure 5) all mill scale wastes from the roughing and finishing stands, approximately 9500 gpm, flow by gravity to the sedimentation basin for the removal of the heavier scale particles. Gravity flow, so as to not break up the heavier scale particles, is necessary for the efficient removal of these solids in this part of the equipment. The effluent from the sedimentation basin flows directly to the mill scale well under the pumping station. River water make-up of approximately 2000 gpm is float controlled into this well. This makeup is necessary to take care of the drawoff of clarified water used in the processing departments in place of well water, and evaporation losses on the mill. The low-head pumps transfer approximately 12000 gpm from this well to the mixing chamber ahead of the clarifiers. This flow is controlled by a diaphragm operated butterfly valve to suit the demand on the system.

Ferric sulphate as a coagulant and lime for pH adjustment are added and thoroughly mixed in the mixing tank. All chemical feeders are automatically controlled according to the flow being pumped to the mixer. Flow through the balance of the equipment is by gravity. After thorough mixing in the mix tank, the wastes flow into the flocculating tanks where by slow mixing, the chemicals, fine and semi-colloidal solids form a suitable floc which will settle in the clarifier. The effluent from these tanks flows through 36-in. pipes to the center wells of the clarifiers for final clarification. This flow is directed downward through the center well so the floc, being relatively heavy, settles on the bottom of the clarifier, with the clear water rising to overflow into the weir troughs. Flow distribution is maintained by slide gate valves in the mixer, flocculators, and 36-in. pipes feeding clarifiers. These valves also serve to divert the flow as necessary for repairs on any part of the clarification system (Figures 6 and 7).

The clarified overflow from the weir troughs flows to the clear well under the pumping station. The high head pumps pick up the clarified water, returning it to the mill system. In addition to the clarified water returned to the mill, approximately 2000 gpm is being pumped to the processing departments for use in place of well water on some units. This not only cuts the well water pumpage to a point that the water table began to rise immediately, but it also serves as a blowdown for the system (Figure 8).

The sludges collected at the center of the clarifiers are pumped to the decanting tanks in the basement of the chemical building. After several hours in the decanting tanks, the heavier sludge is pumped to the rotary vacuum filters on the second floor (Figure 9). The filter cake leaving the filter drops on a belt conveyor which carries it to the conveyor running from the sedimentation basin to the railroad car.

This system has been in operation since August 15, 1955 at flows from 2000 to 13,000 gpm through the clarifiers, with the average flow during mill operations of 11,500 gpm. The mill wastes flowing to the sedimentation basin have varied in suspended solids from 1800 to 4000 ppm. With these variations, the effluent from the clarifiers has consistently remained between 10 to

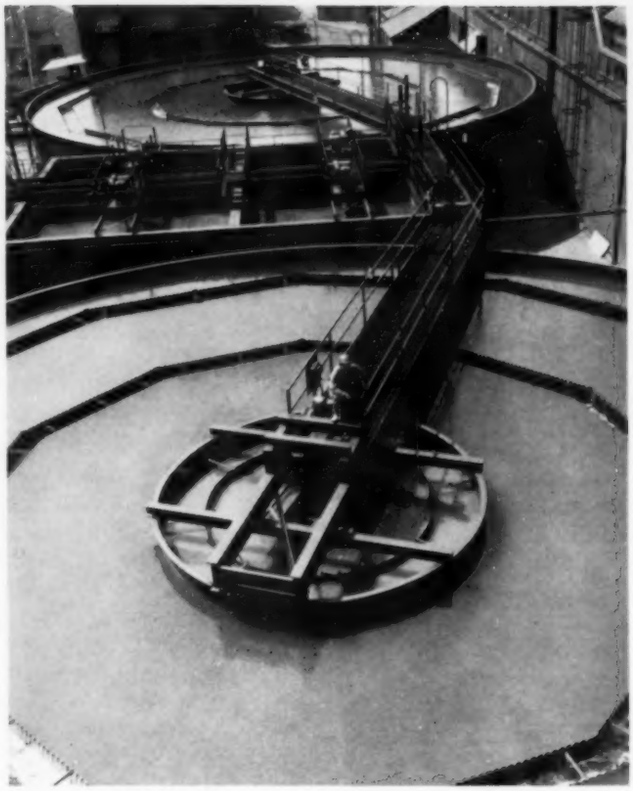


Figure 6 — Clarifiers are placed on both sides of the flocculation tanks.

20 ppm suspended solids, 3 to 8 turbidity, and less than one ppm oil. From 176,000 to 206,000 lb per day of scale have been removed from the combined system. The scale removed from the sedimentation basin analyzes approximately 70 per cent iron oxide, with a moisture content of 30 per cent. Filter cake from the filters averages approximately 40 per cent iron oxide, with a moisture content of 45 per cent.

Figure 7 — Chemical feeders are automatically controlled according to the flow.

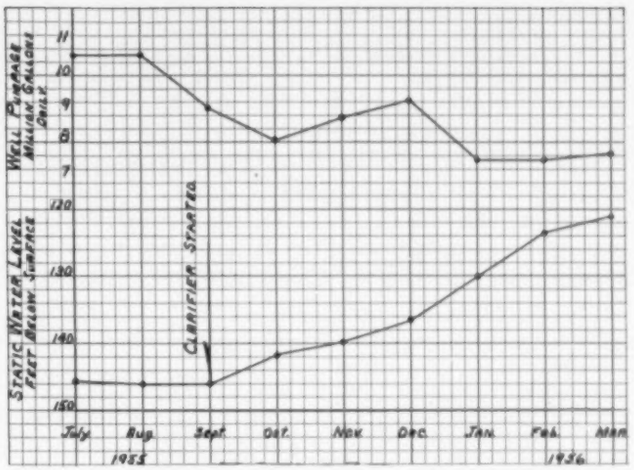


Figure 8 — After water system was put into operation, the water table rose appreciably.

Average figures for a recent period are given in Table II.

TABLE II

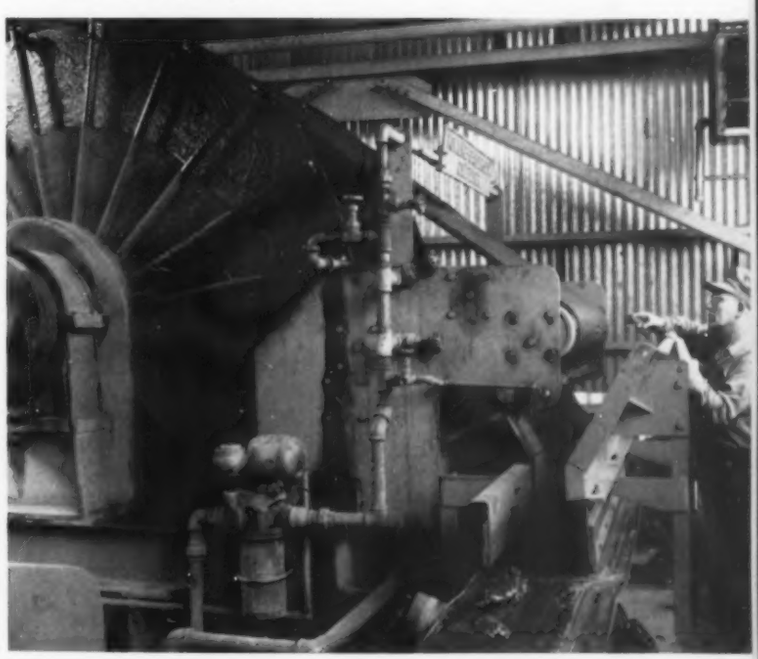
Operating Data—Mill Scale Clarification System Armco Steel Corporation, Middletown, Ohio

Influent mill wastes—suspended solids, ppm	Flow through clarifier, ppm	Clarifier Effluent				Lb suspended solids per day
		Suspended solids, ppm	Turbidity	pH	Oil, ppm	
2450	11,500	15	6	8	Less than 1	196,000

SUMMARY

Very little difficulty has been experienced in the operation of this equipment, and maintenance has been at a minimum. We are now at the point of carrying out

Figure 9 — Filter cake from the rotary vacuum filter drops onto a belt conveyor.



further studies toward making refinements in the operations. Minor adjustments are being made in the coagulant dosage and pH in an effort to improve the characteristics of the sludges formed. This is being done to aid the filter operation and lower the moisture content of the filter cake. Laboratory experiments indicate that it may be advantageous to try some of the new synthetic polymers as our studies progress. As we have not been operating during the hottest part of the year, temperature build-up in the system has not been an acute problem. If temperature becomes a problem, consideration of cooling of a portion of the flow through the system may be required.

We feel that this system has proved to be a very efficient installation for the removal of the heavy and fine mill scales, oil, and grease from all the roughing and finishing mill wastes. We have removed a very sizable pollution load from the Miami River, and are producing a very acceptable water for re-use on the mills and as replacement for well water on certain processing units.

DISCUSSION

PRESENTED BY

JOHN E. KINNEY, Sanitary Engineering Consultant, Ann Arbor, Mich.

G. A. HOWELL, Assistant to Chief Engineer, United States Steel Corp., Pittsburgh, Pa.

F. R. PULLEN, Fuel Engineer, Johnstown Plant, Bethlehem Steel Co., Johnstown, Pa.

GRANT A. PETTIT, Industrial Waste Control Engineer, Armco Steel Corp., Middletown, Ohio

John E. Kinney: Armco has demonstrated that waste treatment should and can be integrated into the overall water economy. Waste treatment here is not an isolated expense but rather a source of water supply—a source of better continuing quality than the river.

Armco's objectives were twofold: abate pollutional discharges and provide a supplemental water supply. The Miami river is subject to very low flows. With the high concentration of population and industry, the waste loads discharged to the river are at times more than the river can assimilate. The river quality is often very poor. The ground water level was dropping too far with the continual pumpage. There was a need for relief in the water supply.

For companies in similar situations, Armco's solution provides direction. But it should be of interest to other companies also—even where a plentiful supply of water is apparently available.

Events in the Chicago district in the past few months have directed attention to mill scale and flue dust recovery practices—and on a federal review basis.

The United States Corps of Engineers, in Federal Court in Chicago, asked an injunction against Republic, Interlake and Wisconsin Steel Corporations that would require the companies to submit to the Corps for approval, plans for the satisfactory treatment of industrial effluents before their discharge into the Calumet river. The basis for the requested injunction is the Navigation Acts of 1899. Article 403 states that the Corps shall review plans and give permits for construction of headwalls, outfalls, etc., in navigable streams. Article 407 states that the discharge of refuse into navigable waters is prohibited.

The Corps argued that mill scale and flue dust are refuse—left over from an industrial operation. As such their discharge can properly be prohibited. They feel that the right to review plans is inherent in Article 403.

All three companies had conventional thickeners for flue dust recovery—all operating at better than 97 per cent efficiency. Scale recovery was by means of conventional scale pits.

In this litigation the defendants introduced data on the loads of solids discharged from their plants in an effort to limit the liability for dredging. The Corps witnesses argued that it is impossible to obtain a representative sample from a steel mill effluent, so that the load cannot be measured. Furthermore, one Corps witness estimated that 50 per cent of the mill scale and flue dust in steel plant effluents were two microns or smaller in size—too fine to be filtered out by an asbestos mat in laboratory analysis—and that these fines would flocculate in the stream and cause silt, sand and other material to precipitate that would not settle of its own accord. Because of this, the only true measure of waste discharge is actually what has to be dredged.

This court argument has emphasized several points: means of measurement of flows and of solids concentrations; settling characteristics of scale and flue dust; flocculation of these solids; and recovery of these solids.

The Armco work has indicated that continuous removal of scale is feasible; that velocity and flow distribution are controlling factors in settling-facility design; that recycling of water with conditioning for reuse is practical; and that short of a filtering medium, there will be a residual of solids in the plant effluent.

There is another area of possible consideration: attention to the possibility of changing processes so as to break the scale away and recovering it dry. This reduces the amount of water necessary, cuts down on the scale that accumulates in the pit and reduces the scale lost to the river.

Mr. Pettit has pointed out the importance of the flow pattern in the design, and the means of distributing flow in order to make it most effective. We have heard many reports that the continuous recovery of mill scale is not practical; that operating difficulties would prevent it from being so. These data would seem to belie that. These data would also suggest that we give more attention to the means of adding the water to scale pits rather than just discharging it into the side of the pit which develops a spiral flow. The attention that was given by Armco to the development of flow distribution within the scale pit deserves, in my opinion, the utmost of consideration.

G. A. Howell: Steel mill scale removal has been and is a constant problem. Increased production over and above that for which scale pits were originally designed incur sewer cleaning and in some cases removal from the stream to prevent pollution. Mr. Pettit and his staff are to be congratulated for their approach to this problem. They have accomplished a two-fold purpose. With increased activity in stream pollution abatement and water conservation, the paper is timely. It discloses what can be accomplished when water resources are limited in the location of some steel mills and also pre-

meditates possible regulations which may be enacted for stream pollution control.

It is interesting to note that, although the design of the facilities was carefully planned, certain difficulties were encountered which further substantiates that mill scale pit design is not an exact science, but is something that must be individually designed to fulfill conditions existing at a particular mill.

Utilization of continuous removal of scale by a drag bucket conveyor rather than periodic removal by use of a clam shell bucket provides full basin volume for greater efficiency and optimum settling time. It is axiomatic that settling of water borne particles is a function of retention time. With only periodic scale removal it is readily discernible that as the depth of the scale increases, the water overflow velocity increases, thus decreases retention time and consequently more scale is carried to the sewers or streams with its collateral problems of cleaning or dredging. This also causes certain losses of scale coupled with the problem of stream pollution. Removing scale by clam shell bucket to maintain full settling volume causes great turbulence with the end result of scale washing over into the sewer system. One of the problems is using the overhead crane to remove scale when almost invariably it is needed for other purposes. The method used at Armco eliminates all these undesirable features and it can be safely assumed that a greater recovery of this material ensues.

The use of flocculation and clarification equipment for removal of fine particles also indicates a good approach. This method has been used extensively in blast furnace flue dust recovery and again reflects what can be done when confronted with the necessity of overcoming industrial water shortages.

The problem also emphasizes a need for developing a rapid determination method for the amount and sizes of particles in industrial wastes systems. Some work is already in progress in this field, but instruments to perform this function must certainly substitute the present methods, plus establishing a uniform standard procedure.

Mr. Pettit's paper is a reflection of what industry can accomplish if left to solve its problems of stream pollution abatement and water conservation without the compulsion of regulations. Further, the contents of this paper should focus attention on scale recovery problems throughout the steel industry.

F. R. Pullen: The increasing demand for water in steel mills poses a severe problem for most operators. There are only a few operations that are situated on large bodies of water where the only problem is one of installing the necessary pumping stations and distribution system.

The author and his associates are to be congratulated on developing a solution for two problems simultaneously. They have augmented their water supply to such a degree that they have reversed the lowering of their water table. They have also solved, at this particular location, a stream pollution problem.

What a price to pay for water! That is the first impression one gets after reading the paper. However, in the case of our industrial health, we must be willing to pay the price of a cure just as we are in our individual personal health problems. When such a cure is found to be satisfactory it is a tribute to the engineering skills of those connected with the project.

The problem of predicting the required capacity for handling recovered scale is appreciated. It must be realized that methods for accurately determining the quantity of scale production are questionable. It would be of interest to know the approach to the problem and how the predicted quantity of scale to be recovered compares to the actual quantity.

Low-head pumps deliver the effluent from the sedimentation basins to the clarifiers. How did the cost of above-ground clarifiers compare with sub-surface units which would not require pumps for transfer of water?

Does scale accumulate in the pump well following the sedimentation basins? What is the proposed method of cleaning the pump well if this is a problem? What is the errosion effect of fines on pumps?

Since a flocculant is added to the clarifiers would any advantage be realized by flocculant addition ahead of the sedimentation basins, thereby reducing the load to the clarifiers and filters?

Water from the clarifiers is returned to the mill system and to other processes. While temperatures are not a problem as yet, corrosion rates may be expected to increase with the increase in water temperatures. Corrosion inhibition by water treatment may be an economical measure.

Grant A. Pettit: I would like to emphasize again, as some of these gentlemen have in their discussions, that there are specific problems at each mill. In other words, one might say we have done it one way and emphasize that each mill installation presents a different problem.

The predicted quantity of scale was determined from a two-month survey of our old style scale pits. Tests were made covering flow and analysis of the effluents from each of the old type sumps to determine the load going through the sumps to the sewers. To this load was added the weight of scale removed from the sumps. Those familiar with this type of sampling and analysis program know that a fair safety factor, so to speak, must be added to these results. We were fortunate in our prediction and have a small excess capacity for further needs.

With the installation of the sedimentation basins we had maintained gravity flow for the heavier scales from the bar mill. In this way, we did not break up the heavier particles, thereby obtaining the maximum efficiency to the gravity separation. This meant that the water level in the sedimentation basin is approximately 12 ft below ground level. To maintain gravity flow through the balance of the system would have meant putting the mixing tank, flocculating tanks, and clarifiers at a great depth. The pumps used to pump the partially clarified water to the mixing tank are stainless steel trim, and have given no trouble.

A small sump pump is operated several times a turn to return any accumulated scale from the pump well after sedimentation basin to influent to the system. Very little scale settles out in this pump well.

We felt that there was no advantage in adding flocculent ahead of the sedimentation chambers. Addition of flocculent at this point would serve to increase the moisture content of the material coming from the sedimentation basin. As approximately two-thirds of the scale is removed from the sedimentation basin at a fairly low moisture content, it was felt that we should only add the flocculent to take care of the very fine scales.

By
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CONTROL OF ATMOSPHERE

▲ PROTECTIVE atmospheres are widely used in a great many industries. Among them, in addition to iron and steel, are the non-ferrous metals, food, paint, chemical, ceramic and rubber industries. In general, these protective atmospheres are indirectly generated in a separate furnace called an "atmosphere generator" and are largely used to prevent oxygen from contaminating the product or chemically uniting with it, resulting in undesirable product qualities or in a hazardous atmosphere subject to explosion. The iron and steel industry uses protective atmospheres for both reasons.

Atmosphere generators used in this industry consist mainly of two types, the exothermic and the endothermic. The first type produces a gas by combustion of the fuel with a deficiency of air and accompanied by production of heat. The lining of the generator acts as a catalyst, thus permitting combustion to take place with considerable deficiency of air without flame being extinguished. Fuels used are natural gas, coke oven gas, propane gas, cracked petroleum gas and kerosene. The control problem here is one of providing the proper mixture of air and fuel.

The gas produced by the exothermic generator may be of several general compositions, each of which may be used for various purposes. Lean gas is composed of hydrogen, carbon monoxide, carbon dioxide, water vapor and nitrogen and is used for purging of furnaces and blanketing processes where the presence of water vapor and carbon dioxide are not detrimental.

For annealing of steel, it is necessary not only to remove the water vapor but also the CO_2 for metallurgical reasons. The gas treating processes will not be discussed here since it is not within the scope of this paper.

Rich gas contains the same constituents, but with larger percentages of combustibles, with the possible addition of small amounts of methane. This gas is largely used for annealing purposes and in order to use it, it is dried and the CO_2 is removed. In addition, CO may be removed by reacting with high temperature steam to form CO_2 and then removing the CO_2 by absorption.

The endothermic generator is used largely in carburizing and carbon restoration processes used in heat treating. This generator produces a gas consisting of hydrogen, CO, water vapor and nitrogen with very small

Figure 1 — Schematic shows operation of ratio meter.

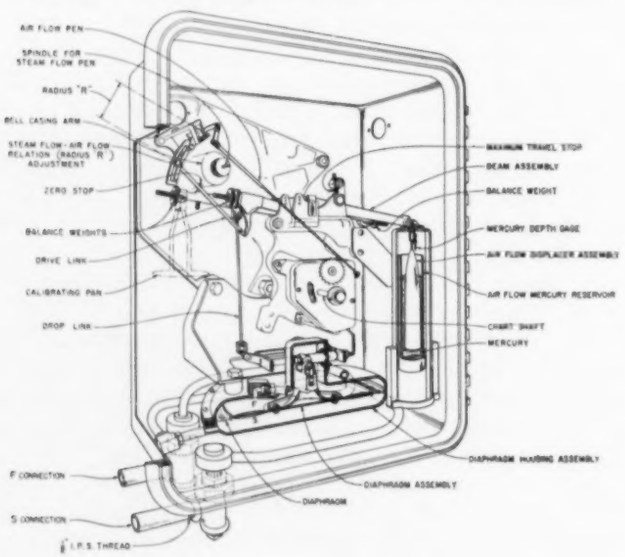
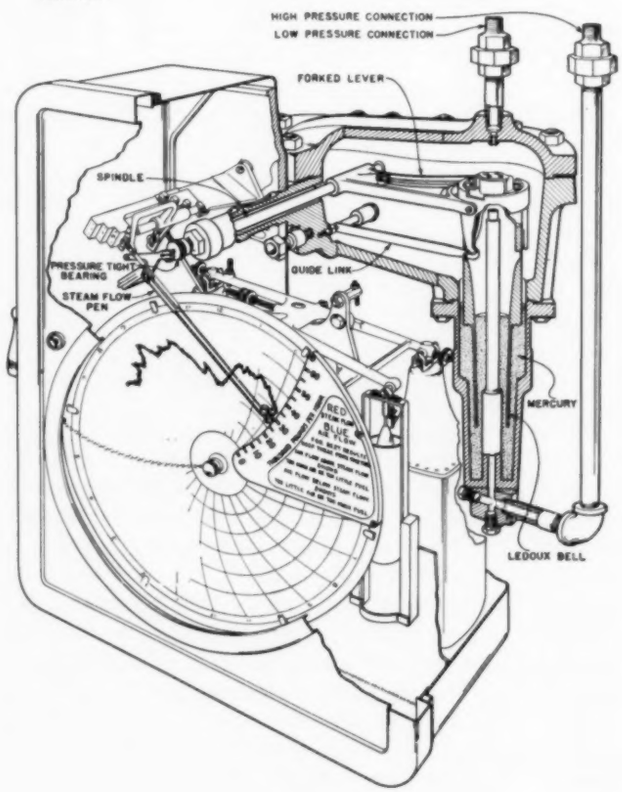


Figure 2 — This ratio meter was designed for use on a boiler.



....qualitative control has become an indispensable feature in the operations of atmosphere generators....not only has product improved but safety has been increased and furnace explosions have been prevented....

GENERATORS

quantities of CO_2 and methane, by burning the fuel with a large deficiency of air. With this type of generator, it is necessary to support the combustion by means of an external source of heat, together with a catalyst. This generator provides two problems of control, one for combustion of the fuel for heating of the gas and catalyst and the other for proper mixture of air and fuel to produce a generated gas which has the proper analysis to produce the finished product desired.

METHODS OF MEASUREMENT AND ANALYSIS

In order to control any process, it is necessary to measure the factors which determine product quality. Since for the exothermic generator, the control problem is one of properly proportioning air to fuel, it follows that one way of accomplishing this is to measure the rate of air flow and the rate of fuel flow and control the ratio of the two. This is quantitative measurement.

For this measurement, several instruments are available. One is the ratio meter shown in Figures 1 and 2. This meter records both the fuel flow and the air flow. If it is desired to change the ratio between fuel and air, this can be done by manual means by changing either gas or air flow rate. This meter utilizes fixed orifices in gas and air lines.

A second instrument shown in Figure 3 is an indicating instrument which indicates rate of fuel flow, air flow, and generated gas flow also using fixed orifices as the primary measuring elements. For certain installations, it may also be desired to measure steam flow to the reversion process where the CO is removed from the generated gas One of the advantages of the orifice type meter is that it permits a nice panel arrangement because of the use of piping for impulse lines only, and because of long life, low maintenance and a good degree of accuracy.

Another flow measuring instrument which can be used is the rotameter. Since this meter measures the flow by passing the fluid through it, it is more adaptable to local mounting and requires individual meters for each flow measurement.

Since volumetric measurements of fuel flow and air flow are subject to temperature and pressure corrections and also since the quality of the fuel and the moisture in the air are not constant, the generated gas for a given measured fuel-air ratio will not have the proper analysis when any of the above conditions change. Quantitative measurements are in most cases insufficient to produce the gas quality desired. For this reason, it is necessary to measure the quality of the gas produced and control the mixture of fuel and air to produce the desired quality.

One instrument which can be used for this purpose is one which measures the specific gravity of the generated gas by comparing a sample of the generated gas with air. This is shown in Figure 4. This instrument will provide a good operating index providing the quality of the fuel used remains fairly uniform. However, in certain sections of the country, the fuel gas used is a mixture whose composition may be a mixture of water gas, propane, natural and cracked petroleum gas in various proportions. Where the final product must be closely controlled and the above conditions exist, the above instrument is not suitable. In addition, speed of response may be inadequate for control.

Another instrument for determining gas quality is the thermal conductivity recorder. This instrument operates on the principle that all gases conduct heat at different rates with hydrogen having by far the greatest conductivity. In this analyzer, a sample of the gas to be analyzed is provided at a constant pressure across a flow control orifice and discharged through the cell to the atmosphere. Figure 5 shows the schematic arrangement. The sample is diffused into the measuring fila-

Figure 3 — This unit will show rate of fuel flow, air flow and generated gas flow.

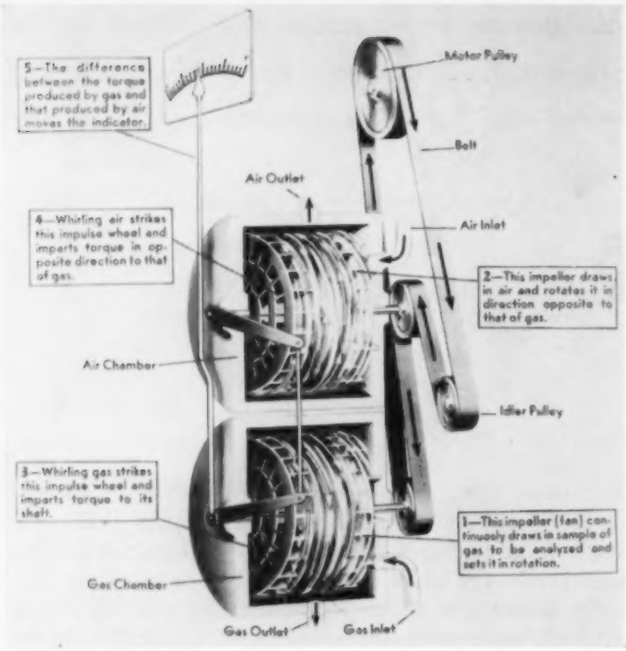

5—The difference between the torque produced by gas and that produced by air moves the indicator.
Motor Pulley
Belt
Air Outlet
Air Inlet
4—Whirling air strikes this impulse wheel and imparts torque in opposite direction to that of gas.
2—This impeller draws in air and rotates it in direction opposite to that of gas.
Air Chamber
Idler Pulley
3—Whirling gas strikes this impulse wheel and imparts torque to its shaft.
1—This impeller (fan) continuously draws in sample of gas to be analyzed and sets it in rotation.
Gas Chamber
Gas Outlet
Gas Inlet

Figure 4 — Steps one to five explain the principle of operation of the specific gravity meter.

ment chamber which contains a heated filament which is connected into one leg of a bridge circuit. In another leg of the bridge is located a heated filament which is contained in a sealed compartment surrounded by a reference gas whose thermal conductivity is known. Any change in sample gas analysis will change the cooling effect of the gas on the measuring filament thus causing a change in bridge output and this is shown on the recorder. This type of recorder is usually calibrated in terms of per cent hydrogen. This instrument is very useful in detecting variations in hydrogen content particularly where only two gases are present. Since this instrument is quite sensitive to flow rate and thus flow rate must be controlled, the time lag in this instrument may be greater than can be tolerated in some applications.

For many applications, the percentage of CO and hydrogen in the generated gas provides an index which is a measure of gas quality useful in maintaining product quality. These factors, which together with methane make up the combustibles constituents of the gas, can be measured by the combustibles recorder and analyzer shown in Figure 6. The schematic diagram is shown in Figure 7. This unit consists of an analyzer and an electronic recorder. The analyzer consists basically of a heated platinum filament over which a measured sample of the gas to be analyzed is passed. The gas sample is mixed with a measured excess of air and burns catalytically on the platinum filament, thus raising the filament temperature. The filament is one leg of an a-c ratio bridge and the recorder continuously balances the bridge and records the percentages of combustibles present.

This analyzer will record the true combustibles content of the gas regardless of the variations in fuel quality, providing the methane content does not vary appreciably, which it seldom does. Thus it is suitable for use over wide ranges in fuel quality and atmosphere conditions. Speed of response is exceptionally good as a relatively large sample of gas is taken with only a small part of the sample used for analysis.

Gas from endothermic generators is generally used for carbon restoration or carburizing processes. For these processes, the carbon potential of the generated gas is most important. Two factors appear to be of greatest use, namely CO_2 and dewpoint. There are many analyzers available for analyzing for CO_2 content. However, since this recorder must be in the 0 to 2 per cent range and must have an accuracy of 0.1 per cent CO_2 or better, ordinary CO_2 recorders are not applicable. One recorder and analyzer, when properly calibrated, will have the accuracy required, but it must be calibrated for the gas to be used. If the fuel gas is changed, the calibration may also have to be changed. This is an infrared absorption analyzer and is generally calibrated in terms of per cent CO_2 in the sample. The analyzer shown in Figure 8 consists essentially of an infrared source, a sample cell, a filter cell, a sensitizing cone with two compartments and a differential thermopile. The sensitizing cone transmits the infrared radiation directly on to the thermopile in one compartment of the cone and the other compartment is filled with a reference gas which absorbs some of the radiation and produces an effect on the second thermopile. The thermopiles are differentially connected to the recorder. The difference in radiation absorbed is a function of the CO_2 content of the gas

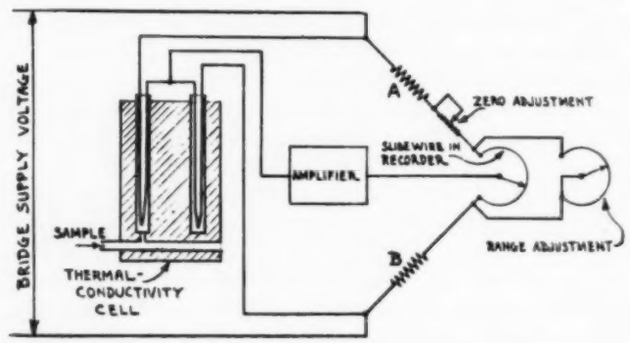


Figure 5 — This gas analyzer uses thermal conductivity for measuring gas concentrations.

when the proper reference gas is used. When properly calibrated, this unit will have the accuracy required for the fuel gas to be used. Due to the high cost of this recorder, its use is restricted to applications where strict quality control may justify its use.

Dewpoint measurement may be made with several different types of instruments. One type utilizes the dewcup principle of observing the temperature at which fog or dew will be formed on a polished metal surface. This type is very expensive since it requires refrigeration units. However, it is adaptable to low dewpoint measurement.

Another type utilizes the principle of absorption of moisture in the gas by a hygroscopic salt in which is imbedded a resistance element of suitable material. The hygroscopic salt not only absorbs moisture from the gas but gives off moisture to the gas so that it is in a state of equilibrium with the gas insofar as moisture content is concerned. The temperature of this equilibrium is measured by the resistance element and this is proportional to the dewpoint. This unit has the advantage of

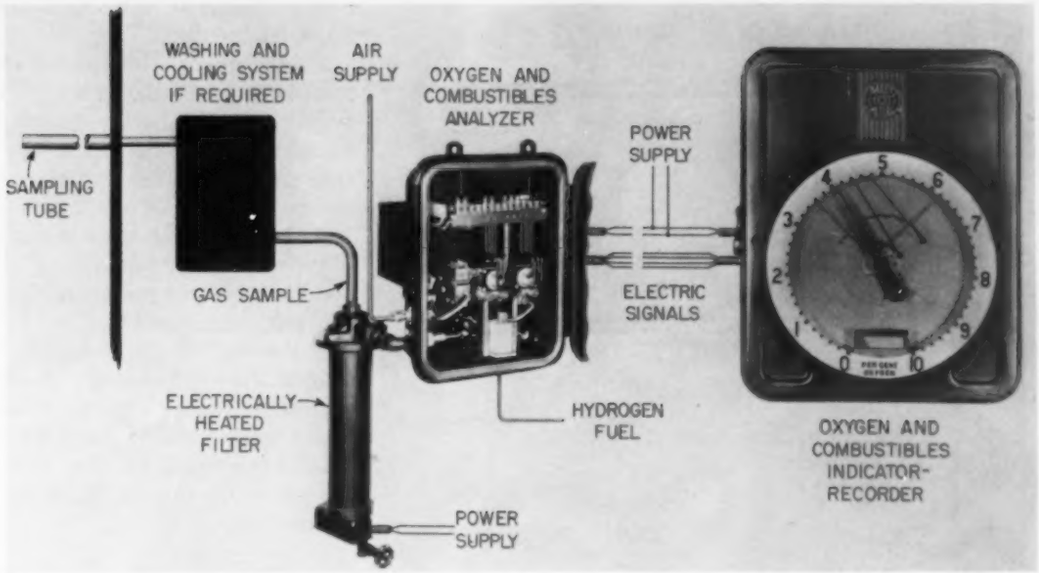


Figure 6 — This unit analyzes oxygen and combustibles.

being relatively low in cost for high dewpoint with relatively high ambient temperatures. If low dewpoints are to be obtained, refrigeration and pressurizing of the sample is required and the cost of this combination approaches the dewcup type.

SAMPLING METHODS

Having discussed the methods of measurement which are important to control, we should now take up the method of sampling which is necessary in order to secure good measurement. For any gas analyzer, the sample must be clean and without entrained moisture. Likewise, it must be kept at a temperature and pressure suitable for the analyzer used. Additional requirements include getting the sample to the analyzer in the shortest time possible so that analyzer may give current information rather than history.

The first step in sampling is to choose a suitable sample point. In most installations this can be made at a point immediately following the cooler unless the cooler produces too much of a time lag. If it can be located following the generator cooler, the moisture will be removed, the sample will be saturated at a temperature below ambient and no additional moisture removal equipment is necessary. If it is necessary to sample ahead of the generator cooler, a sample cooler must be used and the most effective type is the tube within a tube coil-type cooler using the counterflow principle. The moisture must be removed by a suitable trap or water seal.

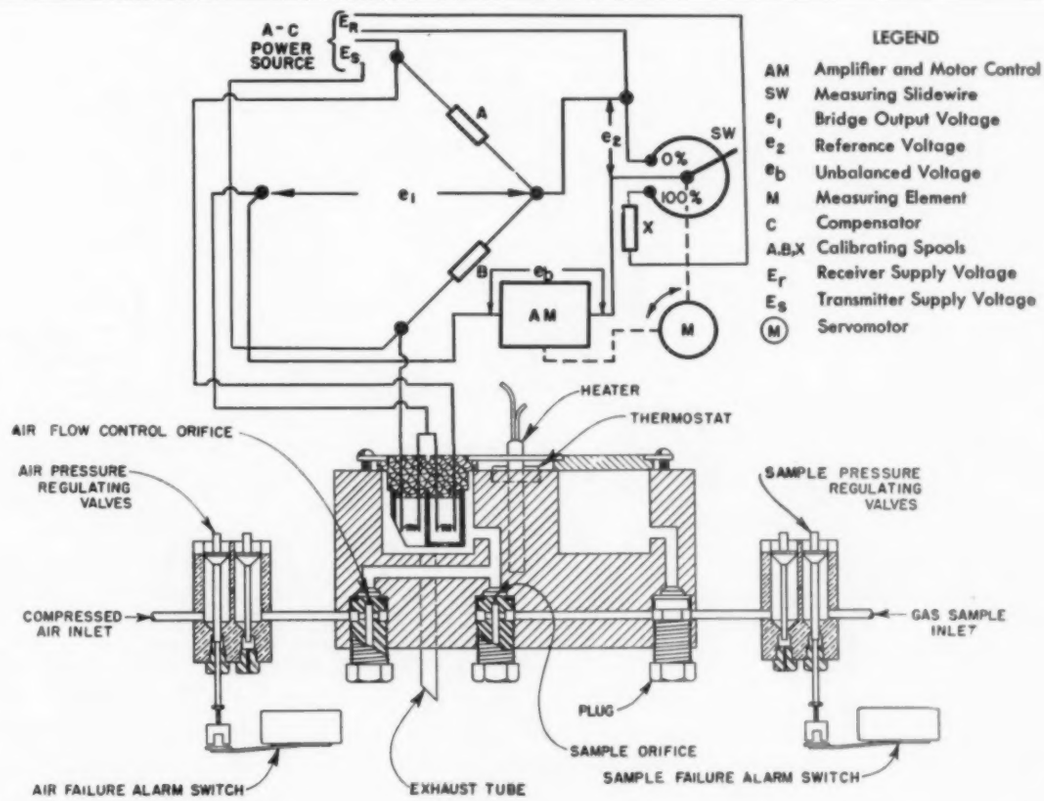


Figure 7 — Schematic diagram of combustible recorder and analyzer.

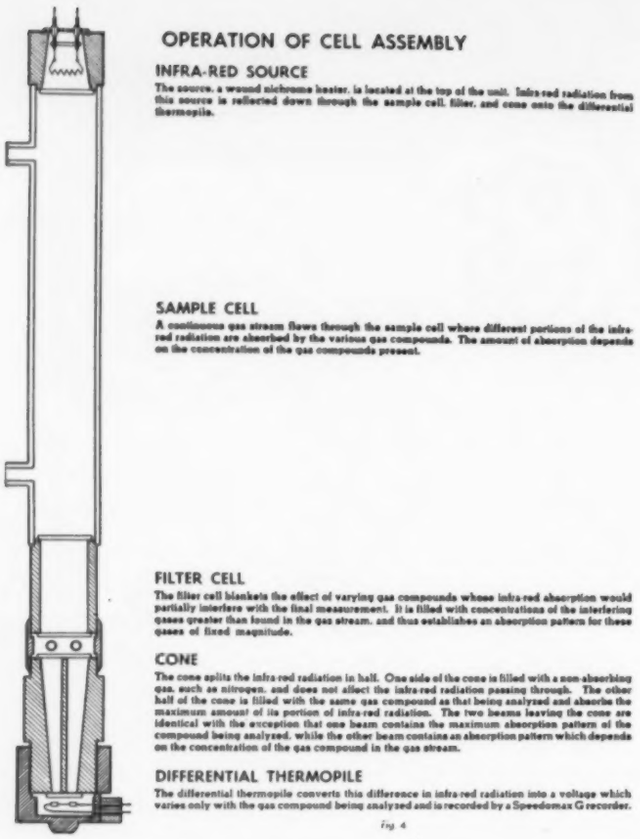

OPERATION OF CELL ASSEMBLY
INFRA-RED SOURCE
The source, a wound nichrome heater, is located at the top of the unit. Infra-red radiation from this source is reflected down through the sample cell, filter, and cone onto the differential thermopile.
SAMPLE CELL
A continuous gas stream flows through the sample cell where different portions of the infra-red radiation are absorbed by the various gas compounds. The amount of absorption depends on the concentration of the gas compounds present.
FILTER CELL
The filter cell blankets the effect of varying gas compounds whose infra-red absorption would partially interfere with the final measurement. It is filled with concentrations of the interfering gases greater than found in the gas stream, and thus establishes an absorption pattern for these gases of fixed magnitude.
CONE
The cone splits the infra-red radiation in half. One side of the cone is filled with a non-absorbing gas, such as nitrogen, and does not affect the infra-red radiation passing through. The other half of the cone is filled with the same gas compound as that being analyzed and absorbs the maximum amount of its portion of infra-red radiation. The two beams leaving the cone are identical with the exception that one beam contains the maximum absorption pattern of the compound being analyzed, while the other beam contains an absorption pattern which depends on the concentration of the gas compound in the gas stream.
DIFFERENTIAL THERMOPILE
The differential thermopile converts this difference in infra-red radiation into a voltage which varies only with the gas compound being analyzed and is recorded by a Speedomax G recorder.
Fig. 4

Figure 8 — Schematic diagram shows operation of cell assembly for CO_2 recorder.

The next step in sampling is to provide the sample at a pressure suitable for the analyzer. In most generator applications this is not difficult as the gas pressure can be from 10 to 15 in. of water. Where this pressure is not sufficient for the analyzer, a pump or aspirator must be provided.

It is frequently considered that sampling from an atmosphere generator is not difficult from a dirt standpoint since the fuel is generally very clean. However some dusting of the refractory lining or carbon formation may take place and this must be filtered out. This can be removed by a felt, cotton, ceramic or paper filter which must be cleaned periodically.

We now have fulfilled all of the requirements for a good sample except to supply it to the analyzer in the shortest time possible. This is a function of the length and the size of the sampling line and the volume of sample drawn in by the analyzer. The sampling line should be made preferably not more than 25 ft long and a ½-in. outside diameter copper tubing or suitable plastic tubing. With this size and length of tubing a sample of one to two cfm of gas will provide a minimum of time lag.

CONTROL SYSTEMS

An adequate sampling system does not assure that the analyzer has sufficient sensitivity and speed of response to provide good control even though it may be suitable for recording average conditions. Over-all speed of response, that is the time lag between a change in fuel input and complete detection of this change by the analyzer, should be no more than 20 seconds to provide adequate control to take care of normal changes due to poor fuel pressure regulation or due to conditions within the generator and associated equipment. If fuel quality is very erratic as in some areas, speed of response is very important.

The system of control to be used should be very carefully selected based on known conditions. These conditions are as follows: (1) degree of control required to satisfy product quality, (2) variation in fuel gas qual-

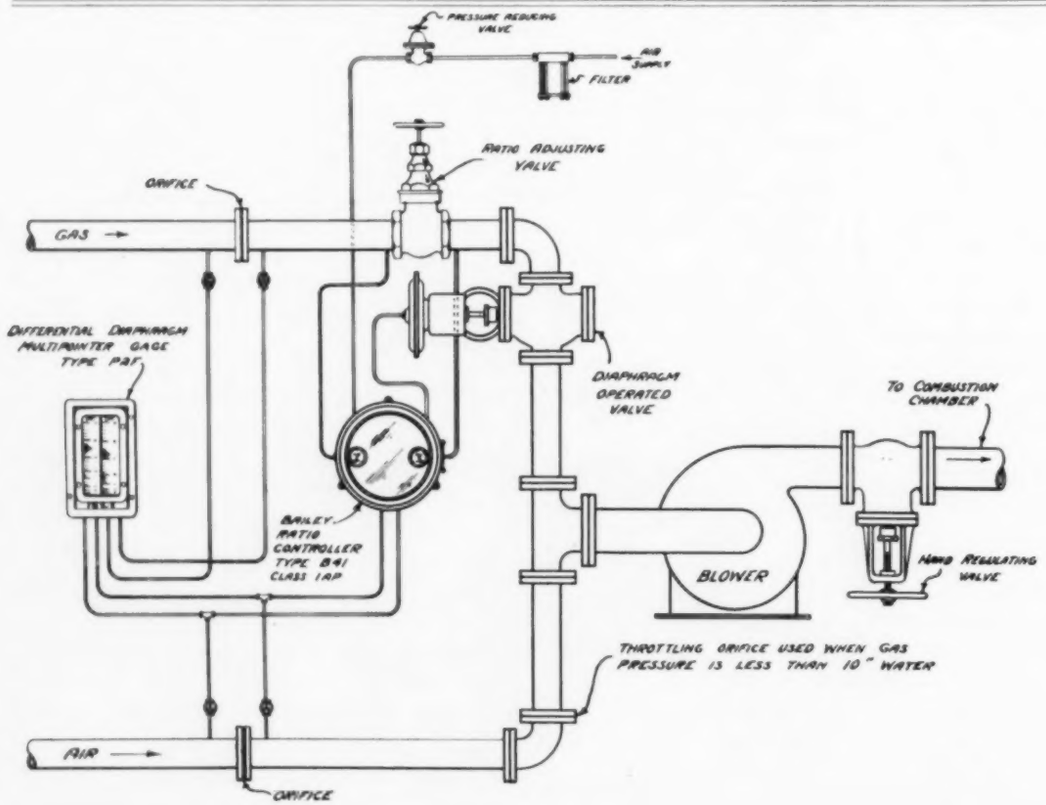


Figure 9 — This system is used for ratio control.

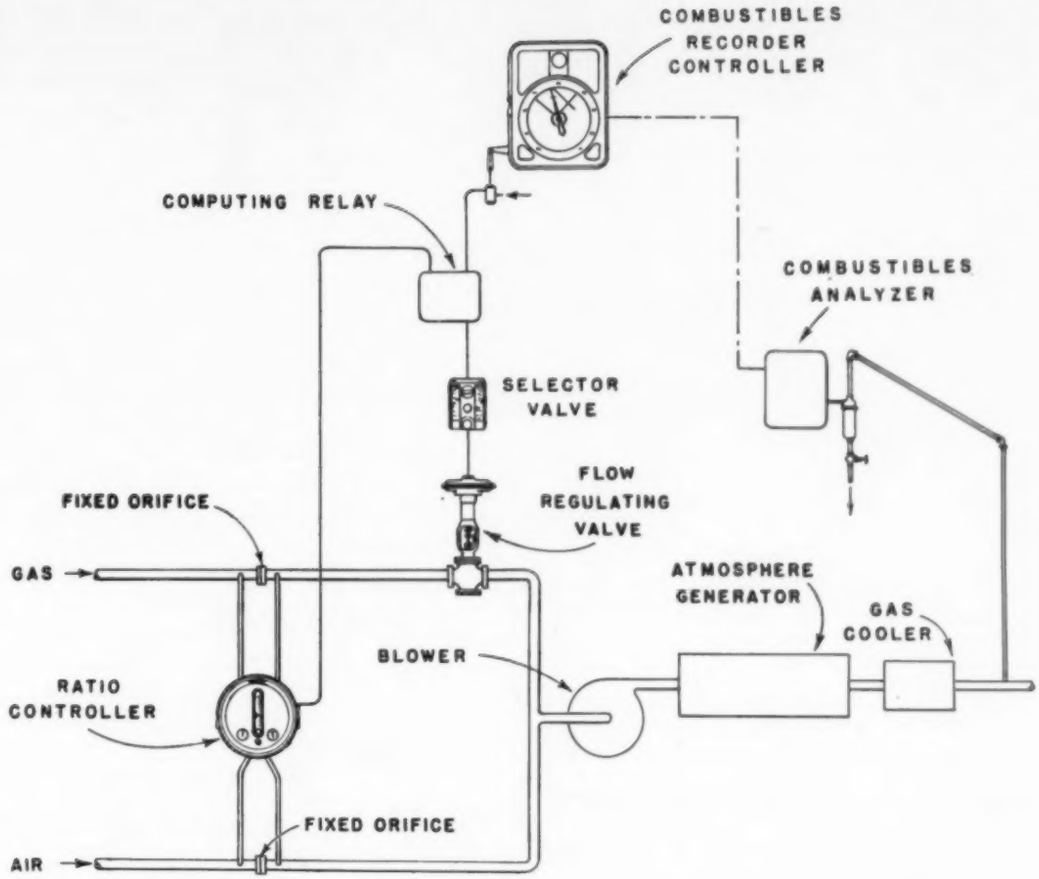
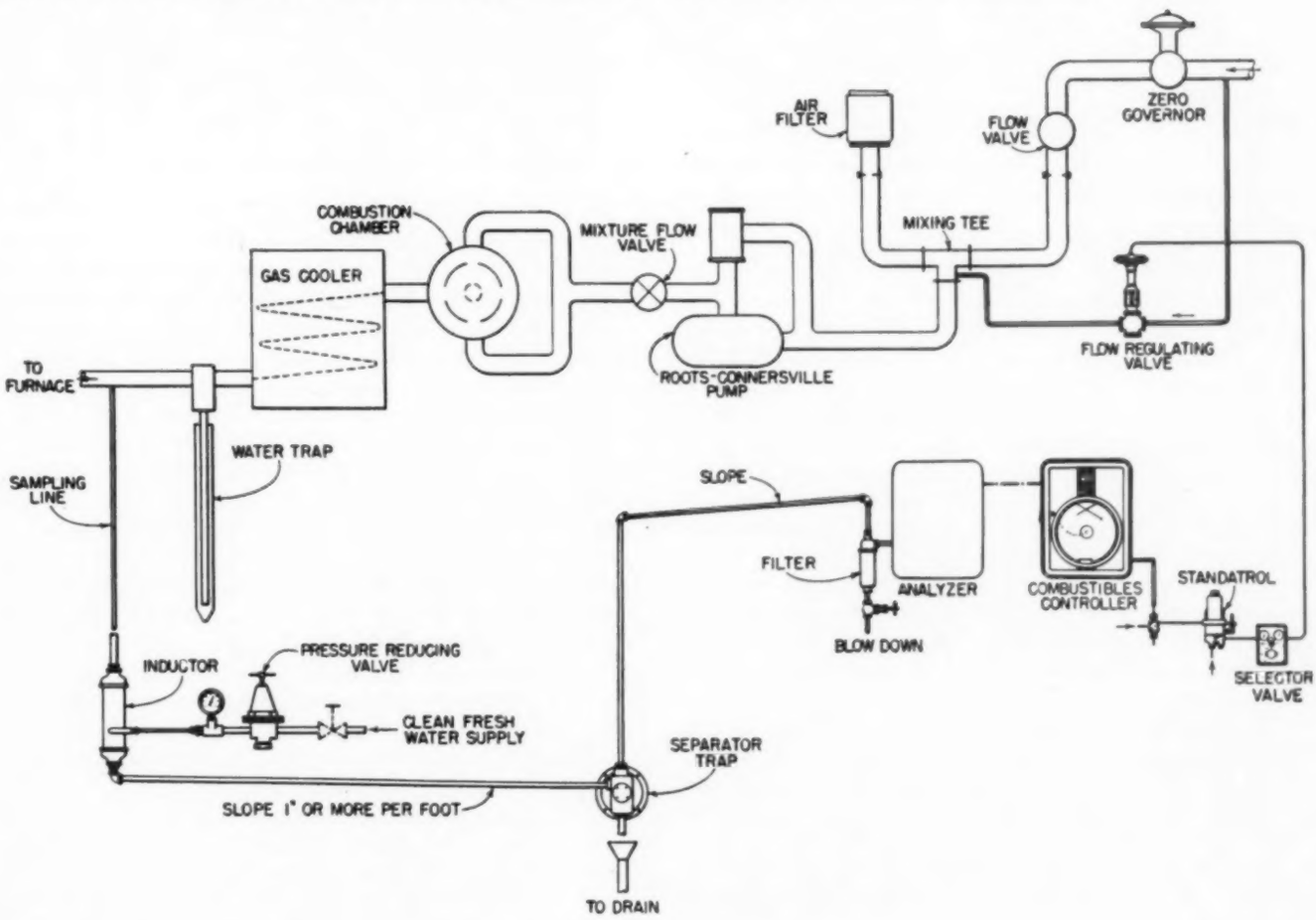


Figure 10— Schematic shows systems used for fuel-air ratio and combustibles control.

Figure 11 — This combustible control for an atmosphere generator uses a trimming or vernier control system.



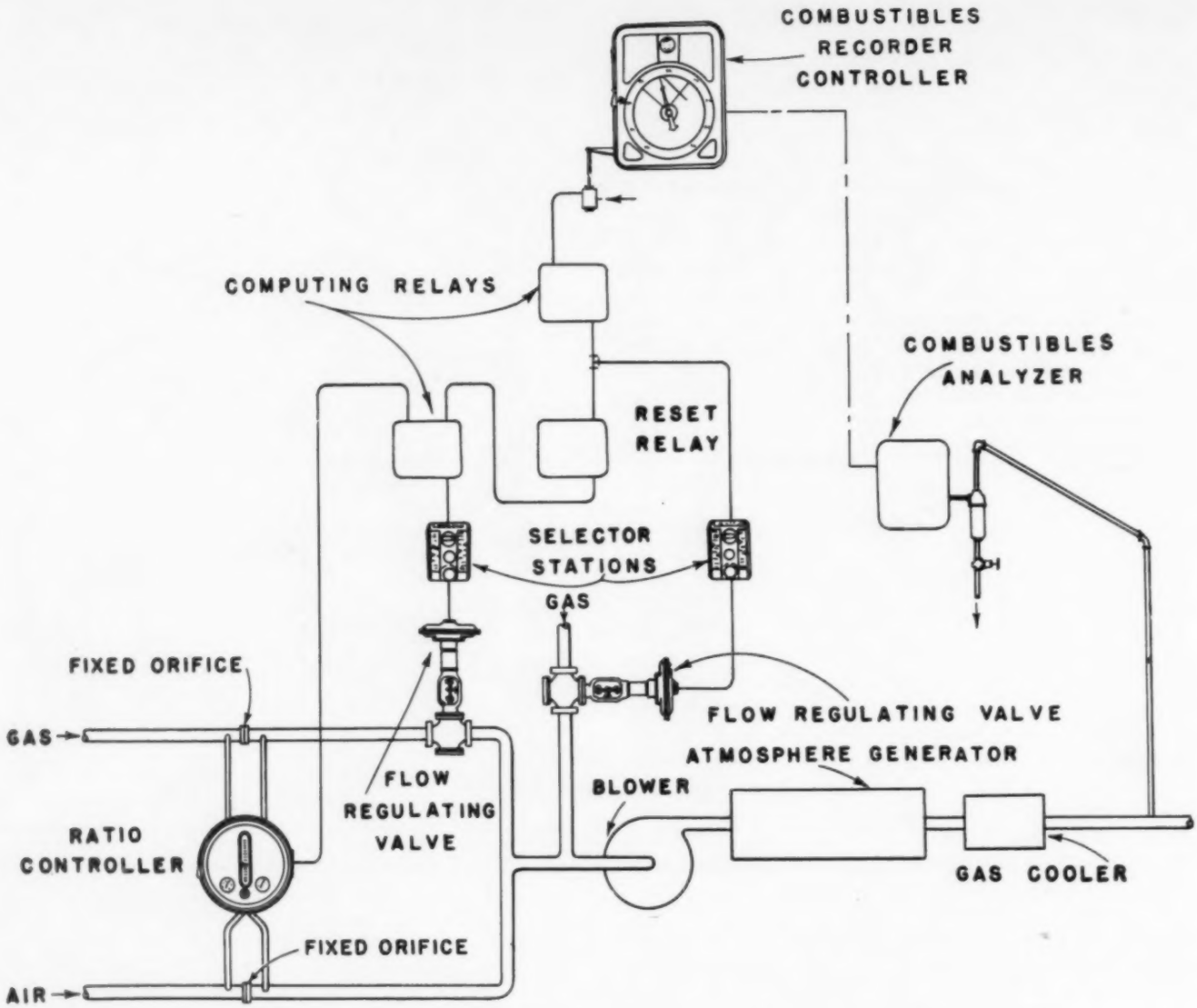


Figure 12 — This control system is designed for use when there is a wide range of combustibles.

ity, (3) set point of control system with respect to perfect combustion, (4) range in generator output.

A basic control system supplied for almost all generator applications is that based on ratio of fuel flow to air flow. This can be accomplished in several ways. Perhaps the least expensive system is the use of a zero governor with which you are all no doubt familiar. This governor can be of two types, one which reduces the fuel pressure to atmospheric and the second which reduces the fuel pressure to that of the air at a point ahead of two orifices sized to proportion fuel to air on an area basis. These orifices may be fixed or may be of the adjustable type whereby the ratio of the fixed openings may be manually varied. In order to adjust the variable ratio orifices, it is necessary that fuel and air flow meters be provided so that the ratio of the two flows may be known.

This system will maintain the ratio of fuel to air within perhaps ± 5 per cent if fuel quality, fuel pressure ahead of governor and temperature of fuel are constant and the generator load is not varied too much. The degree of regulation with these functions constant is dependent on normal variations in atmospheric pressure and temperature and, of course, the sensitiveness of the zero governor. If it is necessary to control at a point very near the theoretical air supply and be sure never to get on the oxidizing side, it is evident that this system will not be adequate. It can be adapted where the control point is sufficiently far from neutral and required degree of control is not great.

Another ratio control system is shown in Figure 9. This system utilizes a ratio controller measuring the actual flow of gas and air by means of fixed orifices. The air is controlled by the demand for generated gas and the fuel is controlled in ratio to it. This system has the same disadvantages as the previous system, but has a much wider range of operation, approximately 4 to 1. Sometimes the differential is taken across the valve as shown and this provides a ratio adjustment.

Still another method of ratio control is that using the so-called mixer or carburetor. This system is similar to the zero governor system previously described, but provides a wider range of operation due to the adjustability of the orifices provided in the mixer.

Where close control of atmospheres is required, it is evident that the ratio control system, regardless of the type will not suffice. A qualitative controller must be used to continuously adjust the ratio control setting

since qualitative controllers are not sufficiently fast to perform the control function alone. The qualitative controller to be used is dependent upon the generated gas qualities desired and the degree of control desired, together with variation in the fuel gas quality encountered.

For most exothermic generator applications, the gas analyzer analyzing for total combustibles is ideal since it is fast and will give uniform results, whether the fuel is natural gas, coke oven gas, kerosene, propane or a mixture of these fuels or mixtures of other hydrocarbon fuels in various proportions.

If the control point is sufficiently far from neutral and the load range is wide and fuel quality variations wide, the system shown in Figure 13 may be used. You will note that only one fuel valve is used and the combustibles controller resets the standard of the ratio controller through the computer relay. This system will give close control.

Where the control point is close to neutral and close control is required with varying gas quality and relatively constant load, it is necessary to make use of a so-called trimming or vernier control system. This is evident when one realizes that to maintain combustibles at one half per cent to say five per cent would require a change in fuel flow of less than one half of one per cent of total fuel input on a very small change in fuel quality. The ordinary control valve cannot be positioned so precisely and provide stability of control. For this application, the system shown in Figure 11 can be used. The basic ratio proportioning can be by means of a zero governor as shown with the combustibles controller regulating the by-pass or trimmer valve or by controlling the ratio adjustment of the mixer or carburetor.

On one such system installed in a Canadian wire and cable plant, the installation was not originally furnished with qualitative control and the gas quality was so variable that thousands of dollars worth of wire were spoiled. Since this system has been installed spoilage has been eliminated.

The above system is limited by the capacity of the trimmer valve. If it is made too small, the fuel quality variation may be sufficiently great to require manual resetting of the ratio frequently. If it is made too large, the degree of control may not be as close as desired.

Where a wide range in load is encountered with wide range in fuel quality, a system of ratio control shown in Figure 12 can be used. The first fuel valve is controlled by the ratio controller. A second fuel valve is controlled by the combustibles controller. The ratio controller permits control over a wide range in load and the trimmer valve and combustibles controller provides a wide range in fuel quality. With the ratio resetting relay shown, wider ranges in fuel quality may be handled. The ratio controller can also take the form of a mixer which controls the ratio, and a combustibles controller which controls the ratio adjustment of the mixer.

For endothermic generators where control of carbon potential is required, the dewpoint or infrared analyzer can be used to reset the ratio controller standard using the same systems as described previously, where the combustibles analyzer was used. The basic control system for the required condition is the same whether dewpoint, CO_2 or combustibles is used as the qualitative controller.

RESULTS

This discussion can cover results obtained by use of qualitative control only from the standpoint of the exothermic generator and the combustibles controller. Use of the other qualitative devices has been somewhat limited and the author is not well conversant with the results obtained. On exothermic generators, many installations which were headaches for the generator manufacturers turned out to be very successful when the qualitative control was added. Some generator manufacturers have recommended its use as a safety monitor to prevent generated gas from getting into the explosive range where the control point is close to this range. While no figures are available as to savings in fuel and product, it is significant that once a user has equipped one generator with suitable qualitative control, the balance of the existing ones are usually converted to control and all new ones supplied with it. It is safe to say that where furnace explosions have taken place, they could have been prevented with qualitative control. In one installation with which we are familiar, no furnace explosion has taken place since the qualitative control was installed, and the qualitative control was installed following a severe explosion which wrecked the furnace.

Improvement in product quality has been marked in one large stainless steel producing plant. The operators claim they can maintain zero oxygen and 0.3 per cent combustibles with the control system. The writer was very familiar with the first atmosphere generator installed in this plant about twenty years ago. The atmosphere generator solved the problems created by trying to anneal using a straight natural gas as the atmosphere. However, it created others which were not solved until fifteen years later when that generator was provided with qualitative control.

Atmosphere generators and qualitative control have become indispensable. One without the other is like a ship without a rudder.

DISCUSSION

PRESENTED BY

C. W. PICKENS, Superintendent—Fuel Dept., Weirton Steel Co., Weirton, W. Va.

C. W. Pickens: Weirton Steel has an installed capacity of approximately 300,000 cfhr of DX gas; 80,000 HNX; 20,000 NX and at the present are installing 40,000 cfhr additional HNX capacity. We also have three 3,000-cfhr NH_3 dissociators.

We use combustible and oxygen recorders to check these gas generating units.

Experience has proven that if a combustibles recorder is to be used for control, the gas sample must be taken as near to the "cracker unit" as possible. We take a sample right out of the "cracker" and cool it with a double tube cooling coil and a U-tube seal; following the cooling coil is a filter and heating unit. The system delay is approximately 9 sec.

Automatic control of our lean gas generators has been a great help in handling the fluctuations that would be caused by changes in the analysis of the natural gas from different fields.

. . . . American Steel & Wire's new rod mill at the Cuyahoga works has a number of new features and production capabilities not heretofore available . . . .

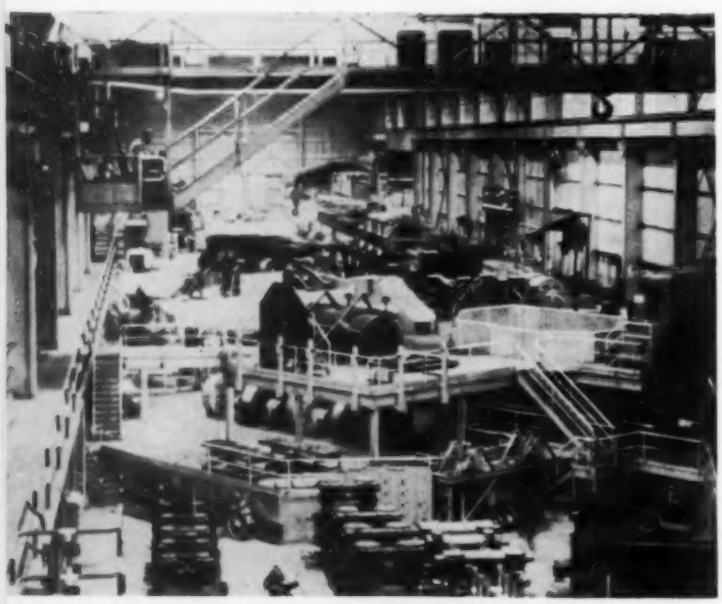
American

Figure 1 — The new rod mill at American Steel and Wire can roll at speeds up to 6000 fpm.

▲ THE new rod mill of the American Steel and Wire Division of United States Steel at Cuyahoga Works in Cleveland, Ohio is considered to be the most modern rod mill in the world. The mill, shown in Figures 1 and 2, is essentially a high speed, high tonnage, close tolerance mill designed to roll all sizes from No. 5 gage up to coarse rods with a maximum diameter of 1½ in. The number of lines and the delivery speeds vary, depending on size being rolled, with small rods having a maximum delivery speed of 6000 fpm with four lines.

At the Joliet Works in Joliet, Ill., to keep from blasting a lot of rock, it was found desirable to locate the mill floor about 14 ft above the yard. This proved to be a very excellent feature, allowing the oil storage and filtering equipment, reel pits, locker and wash rooms, and other equipment to be located on ground level rather than in basements. For this reason, the new mill floor at Cuyahoga Works is also located about 14 ft above the yard with all the equipment just mentioned, located on the ground floor. The cross-sectional drawing, Figure 3, shows this arrangement.

Figure 2 — Mill rolls sizes from No. 5 up to 1½-in.



The mill has been so designed that the entire range of product is rolled from one standard size billet, 3¼ x 3¼ in. x 34 ft long and weighing 1200 lb. Adequate storage and handling facilities have been provided to assure a steady flow of billets to the mill and to keep the hundred or more analyses of steel identified and readily available.

The billets are received either in gondola cars or trucks from the producing mills and are unloaded by electric overhead traveling cranes with chain slings into one of two adjacent billet storage yards. Because of space limitations, these yards are at right angles to each other in the shape of a letter T with suitable transfer media provided. The billet racks are made up of 12 in. wide flange beam posts 12 ft high, spaced about 4 ft face to face, set in concrete. The combined capacity of billet storage is approximately 58,700 tons. Each yard is served by two 15-ton overhead cranes, 87 ft span in the north and south yard and 125 ft span in the east and west yard. The cabs are suspended from and move with the trolleys, thus giving the operator a close look at his lift.

For the first step in charging billets into the reheating furnace, a yard crane deposits several lifts of billets on the receiving table of the mechanical billet separating skids. Four lifts of 15 tons each can be handled. This device eliminates the heavy, hazardous manual labor required on the skids of the old type. The equipment unpiles batches of billets into a single layer for presentation to the furnace approach table either singly or in multiples as desired.

The mechanism consists of stationary and power-operated carry-over skids arranged to produce a cascade effect, which in turn separates and alines the billets and places them on the furnace approach table. The entire skid mechanism is operated by a 50-hp mill type motor connected to an eccentric shaft through a reduction gear unit. Hydraulically-operated stops are provided on the upper tier to aline lifts of billets before they start to cascade. A hydraulically-operated billet discard and turnover device is provided. All of this mechanism, including the approach table and charging ram, is controlled from a glass enclosed pulpit located

Steel and Wire's New Rod Mill

By
W. V. MAGEE
Assistant Chief Engineer
American Steel and Wire Div.
United States Steel Corp.
Cleveland, Ohio

over the approach table from which the operator has a full view of all operations.

The furnace approach table is a conventional roller table which, to facilitate billet handling, is made in two sections, each driven independently of the other.

A ram charging car is straddle mounted over the furnace approach table. Its purpose is to push billets into the furnace and accurately position them lengthwise.

For safety, a disappearing stop has been provided in the furnace end of the table. The sequence of operation is as follows: the table rollers propel the billets to the stop, passing under the tilting head of the ram charger. The cross pusher has previously been operated to clear the run-in space. The stop drops and the ram pushes the billets to a predetermined stop and retracts. As soon as the ram head clears the furnace door the cross pusher may again be operated, but on signal. The ram returns to full retracted position and the stop rises. The operator may move more billets forward on the table to the stop thus completing the cycle.

The billet reheating furnace is side charged, side discharged, two-zone, top-fired with recuperator. The effective heating area is 70 ft long x 38 ft inside of walls. From a horizontal hearth at point of discharge, it slopes upward approximately 1¼ in. per ft to the charging end. The primary heating zone has twelve burners, while the secondary heating zone has fifteen automatically and two manually controlled burners. The combustion air is preheated to 650 F in a refractory tile recuperator located beneath the furnace and here again is an advantage of having the mill floor above grade; the recuperator is on the ground floor.

The furnace will heat 3¼ x 3¼ in. x 34 ft-0 in.

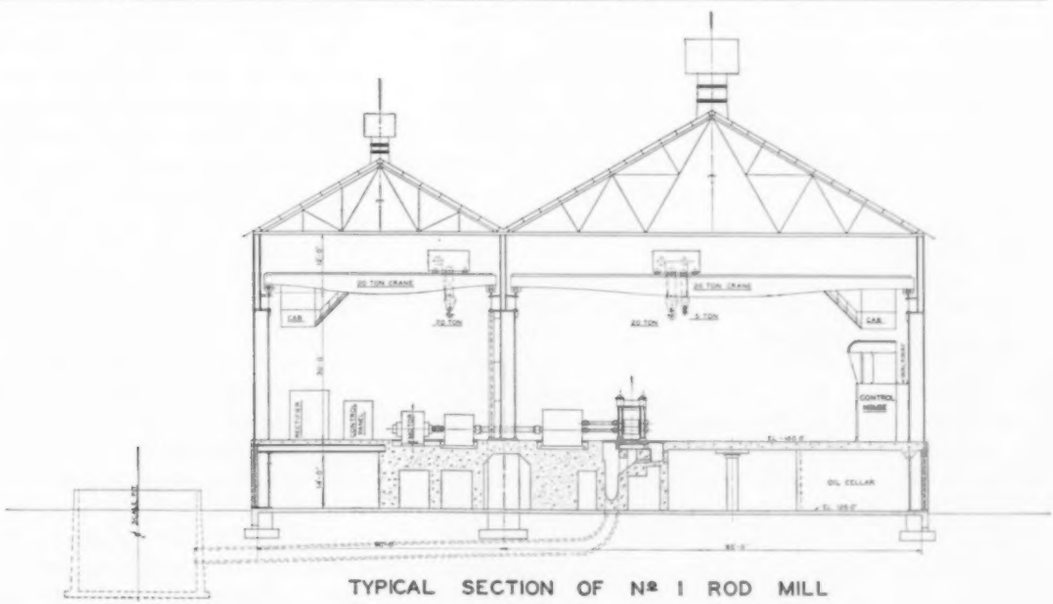


Figure 3 — Mill floor is located above the yard.

billets at the rate of 100 net tons per hour starting with cold steel. The secondary zone will heat 35 tons per hour without the assistance of the primary zone. The fuel consumption is estimated at 1,500,000 Btu's per net ton of steel, heating to rolling temperature. The fuel used is natural gas, coke oven gas, oil or a combination of coke gas and natural gas depending on availability.

The temperature and combustion control equipment was designed for automatically controlling and recording temperatures within the furnace and to maintain a constant predetermined furnace pressure and stack draft as well as maintaining proper fuel and air proportioning and a predetermined flow of fuel to the burners. All of the control equipment is located on the main operating floor in a glass windowed control house so that all conditions can be easily observed by the furnace operator.

The furnace cross-pusher is conventional except that the motor and gear reduction drives are located on the ground floor with connecting rods reaching up through the mill floor to the bell cranks on the pusher arm shaft at the back of the furnace. The cross-pusher motor controls are interlocked to the billet charging equipment as previously mentioned. The cross-pusher is mounted on its own foundation independent of the furnace.

The billets are pushed endwise from the furnace into the first roll stand by a pusher bar gripped by two narrow face flanged pinch rolls electrically driven. The back end of the pusher bar rides in a channel frame, and both the pinch roll housing and back frame are traversed by oil-hydraulic cylinders. This traverse is necessary to line up the pusher bar with any of the several billet positions. The operator sits at a small control desk and looks into the furnace door through a colored glass shield.

The billet pull-out rolls are located on the discharge side of the furnace. This equipment is a pair of pinch rolls—the bottom one being motor driven has a long face to coincide with the width of the furnace door. The upper roll, narrow faced to contact a single billet, is traversed over the face of the lower roll by means of an oil hydraulic cylinder and raised and lowered to pinch the billet by an air cylinder. The function of this equipment is to assist the furnace push-out when necessary, and to return a partial billet into the furnace after it has been cut by the toggle shear in front of No. 1 roll stand in case of cobble.

A four-line billet switch is located after the pull-out rolls and in front of No. 1 roll stand. Its function is to guide billets selectively into any of four active pass lines in No. 1 roll stand, keeping a continuous flow of billets without any intervals of inactivity.

The switch plate assembly consists essentially of two, fixed yet movable as a unit, guides with wide opening at the lead end and narrowing down at the mill end. The equipment is hydraulically-operated with two motions; horizontally to position the narrow end of the guide plate in front of any of the four passes, and vertically to the metal line of the first pass. The control is located close to the furnace door where the operator has an unobstructed view. The toggle shears, one for each pass previously referred to, are mounted on the entering side of the first roll stand. Each shear has the capacity to sever 3¼-in. square billets. They are manually tripped with the moving billets supplying the power to cut.

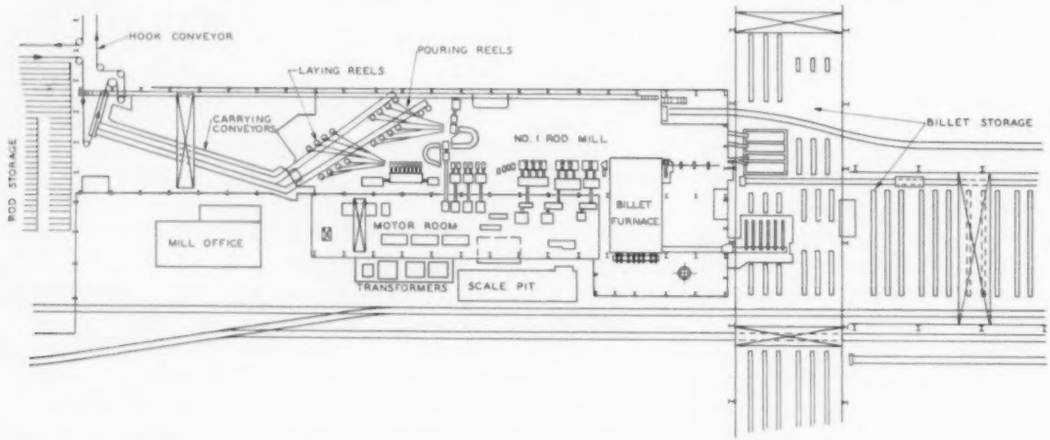


Figure 4 — General arrangement of No. 1 rod mill.

The mill proper consists of a total of 25 stands of varying roll diameters arranged as shown in Figure 4. It will be noted that there are 23 stands arranged in a continuous line and followed by laying type reels. This arrangement is used for rolling all sizes up to $^{27}/_{64}$ in. diameter rods. For rolling $^{7}/_{16}$-in. diameter and larger, stands No. 1 through 15 are used, then repeated through stands No. 16A and 17A into pouring type reels.

All roll housings are of closed top construction. All roll neck bearings are of the oil-flooded precision type. The top rolls in stands No. 1 to 15 inclusive, as well as No. 16A and 17A are oil-hydraulic cylinder supported; top rolls in stands No. 16 to 23 inclusive are supported by springs. The bottom roll chocks in all stands rest on wedges arranged to raise or lower the rolls with one screw for establishing a fixed metal line.

The bottom rolls are axially adjusted by means of a parallelogram device with push and pull turnbuckles.

Mill screwdowns are operated through a worm and worm wheel mechanism for accurate adjustment, all stands except No. 1 by means of a hand ratchet wrench on each screw, with a motor drive on each screw on No. 1 stand. All rest bars are fixed horizontally but have some adjustment vertically and carry slidable guide boxes.

The looping stands No. 16A and 17A are moved endwise by hydraulic cylinders to permit rapid alinement with the grooves in the fixed repeaters.

The arrangement of the gear drives is also shown in Figure 4. The roughing and intermediate trains are driven through single or double reduction gear units

interposed between the main driving motors and the combine drives. Single helical gears are in use for the most part, encased in oil tight, dust-proof, welded steel casings. All drives are arranged for spray and forced feed lubrication from one of the circulating oil systems. The looping stands are directly driven by the motors without reduction units and are the only stands that use pinion housings separately.

The finishing mill drive is of the combine type with spiral bevel gears and mill pinions fully enclosed in a common drive. Gears and bearings are spray and force feed lubricated.

Six separate continuous filtration, pressure type lubricating systems have been provided and housed in two separate rooms on the ground floor, usually called oil cellers. Three systems, labeled D. E. and F., are for the roll neck bearings; one system marked A is for the gear drives and pinions for stands No. 1 to 15 inclusive, No. 16A and 17A, as well as the crop and cobble shear drives. One system marked B is for the finishing mill drive and laying reels, and lastly, system C is for the pouring reels alone.

Between stands No. 9 and 10 are installed four electric crop and cobble shears, one for each strand placed in echelon formation. In addition to their use in selective cropping the front ends of process bars, they are also used for severing any one of the four strands in the event of cobbles, farther down the mill. When cobble cutting, the shears will cut the process sections into short lengths and divert them to a scrap box under the mill floor. Emergency push buttons for cobble cutting are located adjacent to the finishing mill as well as on the main control pulpit.

The regular cropping in process is controlled by paddle switches one for each strand located between stands No. 7 and 8. The length of crop cut is easily controlled by adjusting an electronic timer in the control circuit. The cropped ends are also dropped into the scrap box. Each shear has a capacity to cut the largest process section delivered from the roughing mill. The shears are individually driven by mill type motors, variable voltage, with rotating regulators, and are designed to follow mill speed as determined by a pilot generator on the motor driving stands No. 6 to 9. Power supply is from a six-piece synchronous motor-generator set.

As mentioned previously, small rods from the continuous finishing train are delivered to laying reels. Due to the high delivery speed, this type of reel is required, for the coil is laid on a stationary plate around a retractable center plug by a revolving cone much in the same manner as one would coil a rope or garden hose. After the coil is laid, the center core drops and the coil is pushed out. Eight reels have been provided, two for each strand. A high volume of cooling air may be forced downward through the coils as they are being laid in the reels. A separate blower has been provided for each reel. Each reel is driven by an adjustable speed motor; the speed control of which is automatically adjusted to the speed of the finishing stand. Power supply is from a synchronous motor-generator set located in the main motor room.

For coiling the coarser sizes of rods delivered from the looping stands, eight pouring reels have been provided, and for the heaviest rods, 1⅛ to 1½ in. diameter finished farther back in the intermediate train, two heavy pouring reels have been provided. A pouring reel is made up of two rows of heavy vertical pins mounted in a platen revolving in a tub about a vertical axis. The outside row of pins are of lesser height, so that the rod flows or pours from its delivery pipe at a certain angle aimed downward at the mean center between the pins. The pins on the inner row are flared outwardly. The finished coil is stripped by an elevator plate rising to the top edge of the tube and at the same time the inner row of pins collapse inwardly freeing the rings that have been wrapped fairly tight by pulling the rod after it has left the last roll stand. The coil is pushed off by a sweep arm.

Each reel is driven by an adjustable speed motor, the speed control for which, like the laying reels, is adjusted to the speed of the last roll stand.

The stripping and coil discharge mechanisms on all reels are individually motor driven and fully synchronized and interlocked. Power is supplied by a three-unit synchronous motor-generator set.

The rod delivery pipes to all reels laying and pouring, except the two heavy pouring reels, are equipped with a series of water sprays for reducing the temperature of the rods. The water valve is opened by electric eye control as soon as the front end of the rod reaches the reel and closes after the tail of the rod reaches the reel. Directly following the spray nozzles, each delivery pipe contains a water eliminating section to prevent cooling water from flowing with the rod into the reels.

Means have been provided to supply half weight or split coils of rods finished in the looping stands and coiled in the eight pouring reels. This was done by installing rotary disc diving shears in the delivery pipe section close after the finishing stand. The rod is thrown through the shear knives by a switch pipe, operated by an air cylinder, and controlled by an electric eye and an electronic timer. When the cut is made, the portion of rod following enters another delivery pipe leading to an empty reel. When full coils are being made, the photo tube still controls the switching operation to guide the rod to the proper reel.

Two drag type coil conveyors serve the eight laying reels and are common to the ten pouring reels. These conveyors deliver coils to two carrying type cooling conveyors. Pusher dogs are spaced on 8-ft centers, and dog locations are interlocked with the push off mechanisms of all reels. Delay stations are provided at the transfer points from one conveyor to another and coils move forward only when the carrying conveyors can receive them in spaced relation. Cooling is controlled by portable asbestos cement covers over the carrying conveyors.

Both cooling conveyors deliver simultaneously to a cross conveyor whose function is to transfer the coils to a hook carrier. The hooks are unusual, inasmuch as they are backing up, that is, traveling with the open end to the back. As the coils move along the transfer conveyor, being carried on two chains synchronized with the speed of the hooks, the elbow of the hook rides a cam track and the nose of the hook slips under and up into the coil much as ones forearm hooks into a market basket handle. The hook track then rises and the coil is carried clear.

All conveyors are tied together mechanically and are driven by one adjustable speed motor.

TABLE I

Main Drive Motor Data

Motor no.	Stands driven	Motor horsepower	Motor speeds rpm
A	1–2	600	300/950
B	3–4–5	1250	225/675
C	6–7–8–9	1750	200/550
D	10–11	1500	225/580
E	12–13	1250	225/620
F	14–15	1250	225/620
G	16A	700	200/680
H	17A	700	250/790
J	16–23	1500	690/960
K Double armature	16–23	3000	690/960

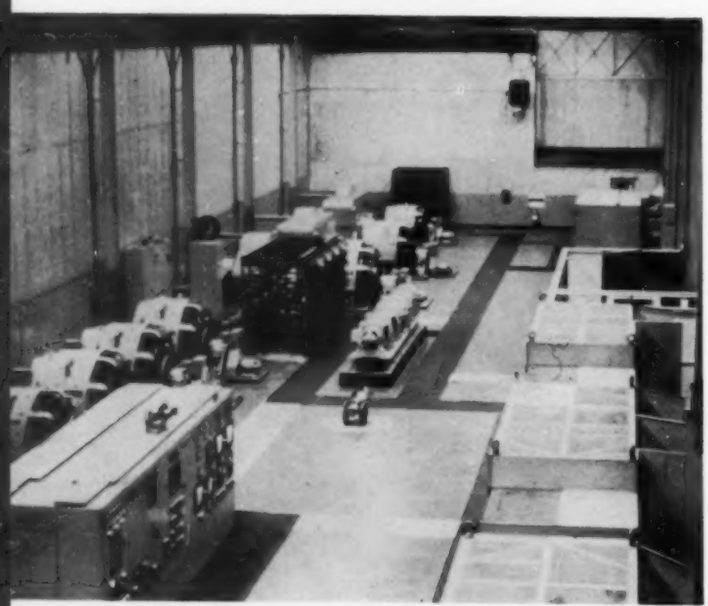
All of the equipment described up to this point with the exception of the reheating furnace, the lubricating systems, and the electrical equipment was furnished and constructed by the mill builder.

The hook conveyor is of the conventional chain type with 550 hooks, backing up, as previously mentioned, spaced on 8 ft centers, making a total length of 4,400 feet. The conveyor speed is adjustable from 20 to 60 fpm by variable voltage to meet the requirement of mill delivery speed. The drive consists of the main driving motor helped by three booster motors through traction drives placed at suitable places along the conveyor. The main drive motor, as mentioned previously, also drives the flat or drag conveyors so that correct synchronization between units is maintained at all times.

Power supply is from a package type motor-generator set in the mill area. The cooling time for coils of rods from the loading station to the beginning of the inspection floor is approximately 39 minutes when the conveyor is running at 50 fpm. The rods are trimmed and given the necessary metallurgical tests while on the hooks passing through the testing area.

At five locations, there are coil unloading stations, where the coils are mechanically removed from the hook conveyor by a pair of movable rams and racked up on a pan conveyor, moving broadside. By means of overhead cranes equipped with hair pin or "C" hooks, the lifts of coils are transferred to racks for storage for our own wire mill use, or to railroad cars or trucks for shipping.

Figure 5 — All main drive motors with the exception of two finishing motors are located in the motor room.



Power for the mill is supplied through the plant substation at 11,500 volts, 3 phase, 60 cycles.

A transformer is installed in an outdoor substation at the mill site to provide 440 a-c power for auxiliaries and miscellaneous alternating-current usages.

All main drive motors are rated at 700 volts direct current, adjustable speed, separately excited, designed for low impact speed drop, rapid recovery and minimum speed regulation. Table I shows the various mill drive motors together with the stands driven, speeds and horsepowers. Speeds below the rated base speed are obtained by operating at reduced voltage.

Power is supplied to the main drive motors from three ignitron rectifiers installed in the motor room. The No. 1 rectifier supplies motors A, B, and C totalling 3600 hp, No. 2 rectifier supplies motors D, E, and F totalling 4000 hp, and No. 3 rectifier supplies the triple-armature 4500-hp finishing mill drive JK, or alternately the two looping mill drives G & H totalling 1400 hp.

The transformers supplying the three rectifiers are oil-insulated, self-cooled and are installed in the outdoor substation adjacent to the motor room.

Starting of the mill is by phase shift control in the rectifier excitation circuits. On a normal start, the bus voltages are rapidly increased from the low starting voltage to the preset voltage and speed conditions under control of the regulators. Any or all motors can be jogged forward or reverse. Reverse jogging is obtained by field reversal.

Since rectifiers are unable to absorb the regenerative power of the motors when the speed of the mill is lowered, regenerative resistors are provided connected across the bus. These resistors are automatically controlled so they do not dissipate energy under normal conditions. Dynamic braking resistors are also provided for normal or emergency stops.

Power for d-c auxiliaries, except shears and reels as previously mentioned, is supplied by a sealed tube type rectifier, metal-enclosed, complete with its dry type transformer, installed in the motor room.

All main drive motors, with the exception of the finishing drive motors H and JK, all rectifiers, switchgear and the majority of the controllers are installed in the motor room adjacent to the mill which is shown in Figure 5. Ventilating air is cleaned by an electrostatic type air cleaner arranged to take outside air or recirculate as desired. Motors H and JK are in the mill area and are supplied with cleaned air from the motor room, which is vented into the mill.

It may be noted that no details of roll passes or rolling practices have been given here. This was intentional inasmuch as with so many various sizes being rolled on this mill, it would be beyond the scope of this paper to show them all. May it just be said that the rolling practice is rather conventional starting with a square billet and using oval, oval passes in the first two stands and then alternately squares and ovals until the finishing round.

Likewise, the production tonnages of various size sections have been omitted. These are controlled by the

ability of the heating furnace to provide billets at the proper rolling temperature.

The mill has already exceeded any known production record of high quality rods.

DISCUSSION

PRESENTED BY

W. W. KNIGHT, Vice President, Morgan Construction Co., Worcester, Mass.

A. F. EISEL, Chief Roll Designer, United Engineering and Foundry Co., Pittsburgh, Pa.

E. C. PETERSON, Vice President, Rolling Mill Equipment Div., Birdsboro Steel Foundry and Machine Co., Birdsboro, Pa.

LOUIS MOSES, Mill Engineer, Bethlehem Steel Co., Bethlehem, Pa.

WILLIAM A. MILLER, Superintendent, Rolling Mills, J. A. Roebling's Sons Corp., Trenton, N. J.

W. V. MAGEE, Assistant Chief Engineer, American Steel and Wire Div., United States Steel Corp., Cleveland, Ohio

W. W. Knight: No progress is made without a certain amount of courage. The American Steel and Wire organization has demonstrated this. Their engineers at Cleveland, and their operating people at Cuyahoga, have had the courage to install a rod mill that has reached far into fields not previously explored.

To my knowledge no rod mill has ever been designed to operate at finishing speeds in excess of 6000 fpm.

No rod mill has ever been put down to produce in excess of 100 tons per hour.

I know of no rod mill of any speed, let alone 6000 fpm, that can divide bundle weights going to the reels.

As if this were not enough, they were willing to explore the air cooling of rod bundles being formed in both laying and pouring reels at speeds and in tonnages never before attained.

These alone, of all the forward steps taken in the design and operation of this Cuyahoga rod mill, are sufficient indeed to command a note of admiration from the members of the AISE and all others interested in rod rolling.

A. F. Eisel: I would like to ask Mr. Magee what tolerance they get on rods and how many wraps they cut off the end of the coil.

Also, I would like to ask the question of why they provide a hydraulic balance on the earlier stands of the rolls and not on the finishing stands, where I believe he said they have a spring balance.

E. C. Peterson: I would like to ask what kind of spindles are used on the mill, and what operating results have been obtained. I notice also that oil-film bearings are used on the mill. To me, this is a new application for that type of bearing, and I would like to ask whether the author feels it is a good application compared with a water lubricated bearing.

Louis Moses: It is noted that Mr. Magee refrains from mentioning what must have been periods of exhaustive study and long deliberation before deciding upon the design of this outstanding mill, all quite additional to that ordinarily preceding the building of new mills. The kind of engineering done speaks for itself in adopting a design reducing 3¼-in. billets to 7/32-in. rods in 23 wholly tandem arranged stands. This was done in the face of all other modern mills relying upon looping tables. It required a high degree of courage of conviction to couple together an ingeniously developed roll-pass design, complete reliance on operating skills, and the new electronic speed controls, especially with regard to the latter's impact-load speed-drop as improved over the earlier equipment available. This sets a new mark on the number of continuous stands which can be run wholly tandem.

Rolling 1200-lb coils at the rate of 100 tons per hour requires the handling of forty 28-in. high coils from each of the strands, or one nearly every 20 seconds arriving at the hook conveyor for cooling. The arrangement of the converging coil-conveyors and their synchronization is an outstanding accomplishment.

The author does not refer to the departure from the 2½-in. billet found at all of the other late mills. It is a certainty that his metallurgists and operators carefully compared the larger billet size in its influence on rod surface quality before adopting it for the otherwise economic value of the large coil.

Every mill operator would be happy to have that stretch of unimpeded mill floor, with only a few handrailings showing, and to have all mill facilities readily available at yard level.

William A. Miller: What type of guides are being used on the finishing mill? At what temperature are the 7/32-in. rods finished? How much tonnage do you roll before a complete roll change on your roughing mill?

How long does it take to make a complete roll change on the roughing mill?

If not changed all at the same time what is the total hours for the complete roughing mill (12 stands)?

W. V. Magee: To answer Mr. Eisel's first question; our tolerance is well within any commercial tolerance required for rods.

Next as to the number of wraps we cut off, sometimes one, but usually less than one. We use springs to support the top rolls in our finishing stands, perhaps because of our good experience in Joliet since 1936; and because of space limitations for a well designed hydraulic support.

To answer Mr. Peterson on the spindles, because of the high speed of this mill, a high grade gear-type spindle with teeth machined on spherical ends is essential. The speed of the last stand is up above 1900 rpm. We have had very good results with them.

As to why we used precision, oil-flooded bearings, we have used water bearings and roller bearings. We have had good luck with both so we thought it was time to try something else, so we tried the oil flooded and up to now they are very satisfactory.

To attempt to answer Mr. Miller's question in regard to guides, we in engineering cannot keep up with the operating department on the changes they make to guides. The temperature of 7/32-in. rod is about 1900 F, or from 1900 to 1940 F.

Our roll changes lately have been dictated by small orders, but we can make a pretty complete roll change, depending on how far back we have to go, in a couple of hours.

. . . . increased production rates and higher material speeds have complicated the problem of designing satisfactory shears . . . . design of shear and drive must be balanced carefully to obtain optimum results . . . .

Electric Drive Systems for bar and rod mill shears

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▲ THE high material delivery speeds required of modern bar and rod mills to obtain increased production can only be accomplished through advances in the design of the auxiliary equipments, as well as in the design of the main drives.

The design of shears which cut these materials "on the fly" becomes one of the most critical problems which result from increased material speeds.

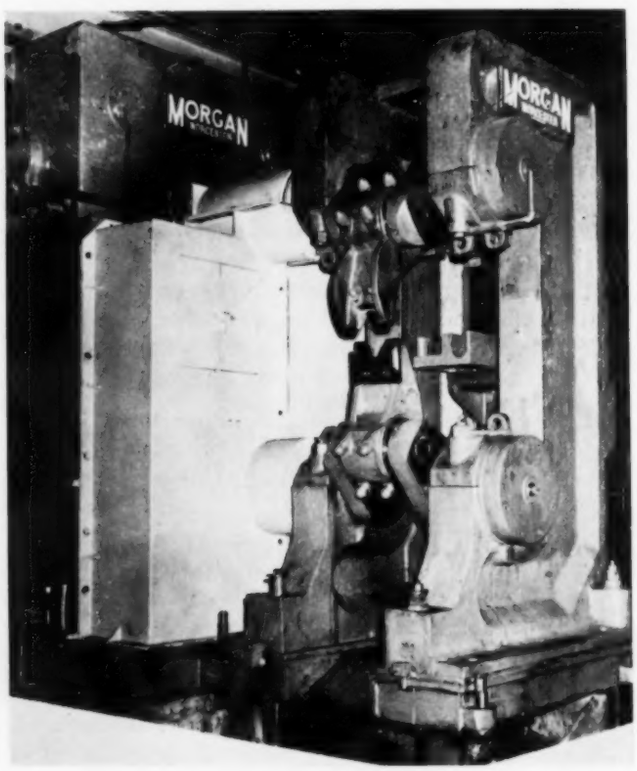
CROP AND COBBLE SHEARS

One of the most fascinating flying shears is the crop and cobble shear.

Operational requirements—The primary purpose of a crop and cobble shear is to cut off the front end of each bar as it progresses through the mill. This "crop cut" is made after a bar has been delivered from the roughing train and before it enters the intermediate train. The front end is cut off to reduce the likelihood of its causing a cobble in either the intermediate or the finishing train, due to cold front ends which have a tendency to split while being rolled.

The secondary purpose of the crop and cobble shear is to cut the oncoming material when a cobble has occurred in the intermediate or finishing train, so that the remaining portion of the material can be diverted from entering the intermediate train. This prevents additional material from being fed into the point of trouble, where it would require extra repair time before the mill could be returned to normal operation. In actuating a "cobble cut," the shear operator may cut the material once, and then divert the remaining section of material onto the mill floor; or, depending upon the type of

Figure 1—Delivery side of a single strand crop and cobble shear for merchant bar mill utilizes crank and cam follower mechanism.



shear, he may initiate continuous cobble cutting, whereby the remaining section of material is cut into convenient lengths for ultimate return to the open hearth.

Mechanical arrangement—Three types of drives have been used for crop and cobble shears. These are: d-c electric, steam, and compressed air.

One type of electric driven shear is shown in Figures 1 and 2. Shearing action is accomplished by means of a crank and cam follower mechanism. Figure 1 shows the delivery side of a single-strand crop and cobble shear. Three shears, as would be used on a multi-strand mill, are shown in Figure 2. Comparison of the relative positions of the three individual shears in Figure 2 demonstrates the crank and cam follower action. Features of this shear, which is generally referred to as a modified rotary type, have been presented in a previous paper (1).*

Another modified rotary shear is shown in Figure 3. Shearing action here is obtained by means of a double crank with cross linkage mechanism.

Both of these shears perform the same function. The primary differences between them are those of shearing action and relative inertia.

Other general types of electric driven shears, such as the rotating drum and the rotary disk shear, have been used occasionally for crop and cobble cutting. Rotating drum shears are normally used for cutting material of smaller cross sectional area. Both of these types will be discussed under the heading "Cooling Bed Shears."

A compressed-air operated three-strand crop and cobble shear is shown in Figure 4. The bottom knife blade of this shear spans all three pass lines, whereas the upper blade is long enough to shear only one strand at a time and is adjusted from one pass line to another by the shear operator.

Recently the electric driven shear has enjoyed the widest usage because of its flexibility, low operating and maintenance costs, and the relatively high amount of time it is actually available for operation. Steam shears are not used for modern mills which utilize mostly d-c electric main drives. Compressed-air operated shears are used occcasionally on low speed applications.

On two and three-strand mills, two basic mechanical arrangements have been used. One arrangement employs an individual shear for each pass line, such as mentioned with regard to Figure 2. In the second arrangement, a movable carriage for one complete shear, as described in Figure 3, or an adjustment of the top knife blade as employed in the compressed air shear of Figure 4, enables one shear to cover all pass lines.

A single shear can successfully crop multiple strands because the front ends of the various strands are staggered with respect to time. However, this arrangement reduces the availability of the shear for continuous cobble cutting, because cutting front ends on trouble-free strands normally receives preference over the cobble cutting operation. For this reason, single shears have not been used to cover all pass lines of four-strand mills, although they have been used on two and even three-strand mills. It should be pointed out that two shears could be used on four-strand mills, each shear covering two strands, with a smaller reduction in availability for cobble cutting.

* Numbers refer to Bibliography at end of paper.

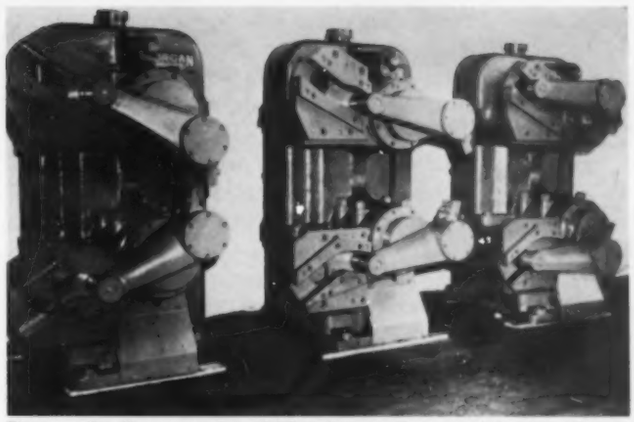


Figure 2—Crop and cobble shears for multi-strand rod mill utilizes crank and cam follower mechanism.

Figure 3—Three-strand crop and cobble shear utilizing double crank with cross linkage mechanism; left-hand cranks carry shear blades; cross linkages connect to right-hand cranks, which define the follow-through action.

Figure 4—Entry side of three-strand compressed-air-operated crop and cobble shear, used for merchant bar and rod mill.

All electric driven shears for crop and cobble operation, except the rotary disk shear, operate on a start-stop cycle utilizing adjustable voltage d-c control. The start-stop cycle requires the shear to (1) Accelerate to cutting speed from standstill before a cut, (2) Make the cut, and (3) Decelerate to standstill and wait at the standby position for the next cut.

Selection of motor and power source—The primary requirement in the selection of a shear drive motor is that it be able to accelerate the shear knife blades to speed slightly higher than maximum material speed before the blades come into contact with the material. If the drive is selected on this basis, it will generally be suitable for shearing the material. Rms heating is not generally a factor in the selection of drive motors for crop and cobble shears because of the comparatively great length of rest time between cuts. When a single shear is used to cover several pass lines, the rms heating should be checked.

Several examples will be given to point out why increased production rates can place strenuous requirements upon start-stop shear drives. The examples also emphasize the need for close cooperation between the mill builder and the electrical manufacturer in the early design stages. Mechanical constants of the shear design, such as the circumference of the shear knife travel, shear inertia, gear ratio and accelerating angle, often can be varied to obtain an improved overall drive. When using standard AISE mill auxiliary motors, the gear ratio determined arbitrarily by matching load inertia to motor inertia is not necessarily the best choice, nor is it always feasible. Standard 230-volt motors are used wherever practical, although the choice of special high-voltage armatures may prove to be more advantageous in some cases.

Typical data for a modern rod mill crop and cobble shear are given in Table I.

The calculating methods used in Table I are not new, but they deserve a few comments. It should be noted that the maximum knife speed has been selected at 110 per cent of the maximum material speed. The linear speed of the knife blade should be kept higher than the material speed within the cut zone. This is to insure against hooking of the front end of the cut section, which is caused by knife speed dropping below material speed within the cut zone. This phenomenon is encountered primarily at low material speeds and when cutting large material cross sections. Hooking can cause difficulties in threading material into the entry stand of the intermediate mill. On the other hand, knife speed cannot be set too far above material speed. This could cause the cropped material to be thrown beyond the crop pit and onto the mill floor; also, excessive knife speed tends to distort the front end of the cut section and could thereby cause a cobble in the intermediate mill. The permissible difference between knife speed and material speed depends upon the design of the shear, and, in some cases, the difference must be held within quite narrow limits. It is desirable to maintain approximately a fixed relationship between knife speed and material speed over the entire range of material speeds.

Table I shows that an accelerating torque of 1.75 times rated motor torque is required for this shear. This is well within the capabilities of the motor selected.

Table II gives the data for a modern bar mill, where the larger material cross section reduces the accelerating angle of the shear. This is one factor which tends to increase the accelerating torque requirement. The higher material speed has a two-fold effect upon the required accelerating torque: it reduces the time

TABLE I

Electric Crop and Cobble Shear

I.	Shear data		
	Material speed, maximum fpm		750
	Shear accelerating angle, revolutions		0.75
	Knife travel circumference, ft		4.0
	Inertia including gear, referred to motor shaft, lb-ft^2		135
	Gear ratio		3.23:1
II.	Motor, brake, and coupling data		
	Motor selected: AISE frame 612, 75 hp, 515 rpm, 230 volts, d-c, shunt-wound		
	Motor full load torque rating, lb-ft		765
	Motor counter emf constant, at rated field excitation, volts per rpm		0.418
	Inertia, at motor shaft, lb-ft^2		
	Motor, with armature fan	123	
	Brake wheel, 10-in.	4	
	Coupling (estimated)	8	
	Total, lb-ft^2		135
III.	Calculation of average accelerating torque		
	Total inertia (shear, motor, brake, and coupling), lb-ft^2		270
	Maximum linear knife speed, rpm (assume 110 percent of maximum material speed)		825
	Maximum motor speed		665
	(825 maximum knife fpm) (3.23 gear ratio) / (4.0-ft knife travel circumference)		
	Motor accelerating angle, revolution		2.42
	(0.75 revolution shear accelerating angle) (3.23 gear ratio)		
	Average motor accelerating rate, rpm per sec		1520
	(665 rpm max)^2 / (2) (60 sec/min) (2.42 revolution accelerating angle)		
	Total accelerating time, sec		0.437
	(665 rpm change in speed) / (1520 rpm per sec average accelerating rate)		
	Average accelerating torque, per unit		1.75
	(665 rpm change in speed) (270 lb-ft^2 inertia) / (308) (0.437 sec) (765 lb-ft rated motor torque)		
	Motor voltage at maximum speed, volts		293
	(665 rpm) (0.418v/rpm) + (15v brush and resistance drop)		
	Overload torque rating of motor, frequently repeated at 293 volts, per unit		2.70

TABLE II

Electric Crop and Cobble Shear

I.	Shear data		
	Material speed, maximum, fpm		900
	Shear accelerating angle, revolutions		0.612
	Knife travel circumference, ft		4.0
	Inertia, including gear, referred to motor shaft, lb-ft		1100
	Gear ratio		1:1
II.	Motor, brake and coupling data		
	Motor selected: AISE frame 618, 200 hp, 415 rpm, 550 volts, d-c, shunt-wound		
	Motor full load torque rating, lb-ft		2530
	Motor counter emf constant, at rated field excitation, volts per rpm		1.274
	Inertia, at motor shaft, lb-ft^2		
	Motor, with armature fan	580	
	Brake, wheel, 16-in.	48	
	Coupling (estimated)	30	
	Total, lb-ft^2		658
III.	Calculations of average accelerating torque		
	Total inertia, lb-ft^2		1758
	Maximum linear knife speed (assume 110 per cent of maximum material speed), fpm		990
	Maximum motor speed, rpm		248
	Motor accelerating angle, revolutions		0.612
	Average motor accelerating rate, rpm per sec		835
	Total accelerating time, sec		0.297
	Average accelerating torque, per unit		1.88
	Motor voltage at maximum speed, volts		341
	Overload torque rating of motor, frequently repeated at 341 volts, per unit		3.05

available for acceleration and increases the maximum speed to be reached.

These factors make it necessary to check both the rate of rise of current and the maximum current that the motor and the power source must commutate in order to develop the average accelerating torque required. A trapezoidal torque-versus-time curve is assumed in order to obtain an approximate evaluation of the accelerating duty to be met. In addition, it is assumed that the relationship between motor torque and motor current (i.e., motor torque constant) remains constant over the range of torque and current values considered.

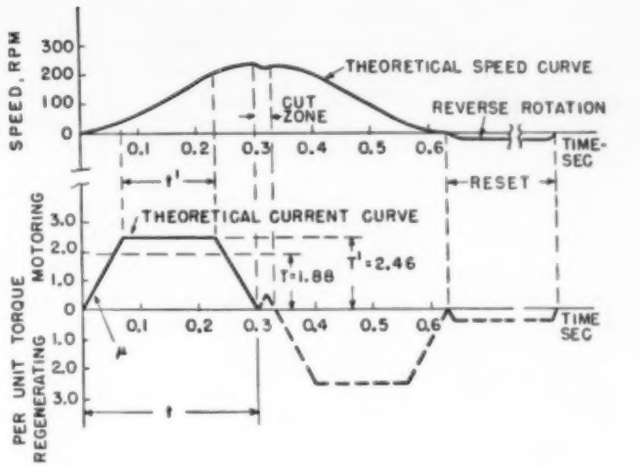
Figure 5 shows the calculation of rate of rise of current and maximum current using this trapezoidal curve approximation. A rate of rise of current of 30 per unit per second has been assumed and the resulting maximum torque requirement of 2.69 per unit has been determined by this calculation. At the maximum motor voltage of 341 volts, its frequently repeated current rating is 3.05 per unit. The margin of 3.05 over 2.69 is considered to be adequate. Actually, maximum torque is encountered only up to approximately 195 rpm, where the frequently repeated current rating would be 3.20 per unit.

It should be appreciated that some margin must be maintained in these calculations because of the approximations made. For instance, friction has not been considered, nor has the effect of motor armature reaction which would decrease the value of motor torque constant in the regions of high torque values. In view of the short cycle times involved, the transient effect of armature reaction will be noticeable only in the final portions of the acceleration period. Experience has shown that it is difficult for the electrical system to fill the trapezoidal curves which are used in the approximate calculations. Therefore, the actual maximum current will be greater than calculated in order for the motor to produce the required average accelerating torque. This is the primary reason for maintaining margin in these calculations. The type of power source, the motor, and the control system will determine how effectively this trapezoidal curve can be filled.

Where more accurate calculations are required, an analogue computer study is made utilizing design constants for the shear, the motor, the power supply, and the control system. It is up to the electrical manufacturer to determine from the approximate calculations whether a computer study is necessary. This decision is based upon past experience and knowledge of transient characteristics of the system components. Even when a computer study is indicated, the approximate calculations will have served a useful purpose by providing a basis for the initial selection of electric equipment for the first computer trial.

The results of a computer study on an actual installation will be shown for a cooling bed shear.

Referring again to Figure 5, the rate of rise of current, together with the resulting value of maximum current, makes it evident that a special generator or a rectifier must be selected as the power supply. It is also evident that transient response of all the system components must be considered in view of the short cycle times involved. The high rate of rise of current must be



LEGEND - BASIC EQUATIONS

T = AVERAGE ACCELERATING TORQUE (SEE TABLE II) = 1.88 PER UNIT

μ = RATE OF RISE (CURRENT) = 30 PER UNIT / SEC (ASSUMED)

TIME $t' = \left[t^2 - \frac{4(t)T}{\mu}\right] = (0.297)^2 - \frac{4(0.297)(1.88)}{30}\Big]^{\frac{1}{2}} = 0.116$ SEC

MAXIMUM TORQUE $T' = \mu\left(\frac{t - t'}{2}\right) = \frac{30(0.297 - 0.116)}{2}$

= 2.69 PER UNIT

Figure 5—Crop and cobble shear maximum torque calculations.

made available from the power supply in order for the motor to produce the average acceleration torque required without demanding peak currents which exceed the commutating ability either of the motor or of the special generator or rectifier power source.

Control system—In addition to normal control functions, a shear control system provides several special functions. One of these is the control of the forcing effort applied to the power source in order to produce the required rate of rise of armature current. A second special function is to match the speed of the shear to material speed during the actual cut.

A one-line elementary diagram of the control system for a rod mill crop and cobble shear is shown in Figure 6. An adjustable voltage d-c control system is required because of (1) a start-stop cycle of operation with high average accelerating and decelerating torque requirements, and (2) automatic speed matching between knife and material over the entire range of material speeds.

Controlled forcing of the power source during acceleration is obtained by regulating the rate of change of armature circuit voltage until the shear attains cutting speed. The control then undergoes a smooth transition into a generator voltage regulator, wherein the voltage of the shear generator is compared against a reference voltage representing material speed. The reference voltage is obtained from a mill pilot generator coupled to the delivery stand of the roughing train. This voltage comparison arrangement enables the shear to adjust automatically to the range of material delivery speeds. The voltage regulator also controls the speed of the shear during the continuous cobble cutting operation. By adjustment of the regulator during installation, the shear speed can be made sufficiently higher than material speed to prevent hooking throughout the range of material speeds.

After the cut has been completed, controlled forcing of the power source for deceleration is again obtained by regulating the rate of change of armature circuit voltage until the shear attains zero speed. Voltage relays across the mill pilot generator, in conjunction with the shear cam limit switch contacts, determine the shear crank position at which deceleration is initiated. Changing the initiation point as a function of material speed helps to bring the shear to rest at approximately the same standstill position over a range of delivery speeds. Referring to Figure 6, it should be noted that voltage relay 1VR will be required where the range of material delivery speeds is 1.6:1 or greater. Both voltage relays 1VR and 2VR will be required for material speed ranges of 3.2:1 or greater. Contacts 2, 3, and 4 on the

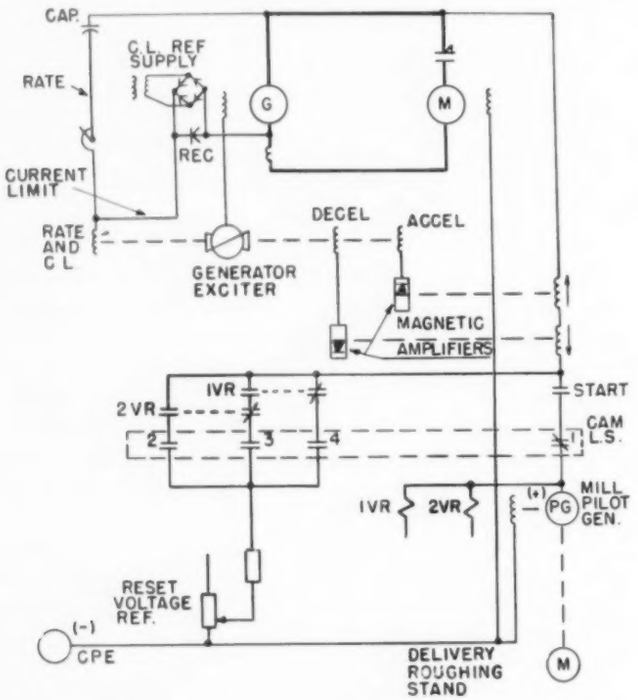


Figure 6—One-line elementary diagram of rod mill crop and cobble shear control.

shear cam limit switch close in sequence after the cut has been made.

As the shear approaches zero speed, the regulator again undergoes a smooth transition from a rate regulator to become a generator voltage regulator, wherein the voltage of the shear generator is compared to a small negative reference voltage. This negative reference voltage regulates a slow reverse speed operation whereby shear returns to standby position. This operation, generally referred to as resetting or "rocking," is described below.

A shear requiring, for example, 250 degrees of rotation for acceleration from rest to top cutting speed will require almost 250 degrees of additional rotation for deceleration to standstill (if average accelerating torque equals average decelerating torque, and the effects of friction and windage are ignored). In rotating a total of 500 degrees, the shear will have overshot its standby position by approximately 140 degrees, and will therefore be required to reset by reversing to standby position. This cycle is shown in Figure 7.

Such a reset cycle is considered to be a normal function of most high speed start-stop shears. The resulting 250 to 285 degrees available for acceleration and deceleration make the shear duty cycle easier to meet than if these angles were limited to approximately 180 degrees and a resetting cycle were not permitted. Adjustable voltage control can readily be set up to provide the resetting function.

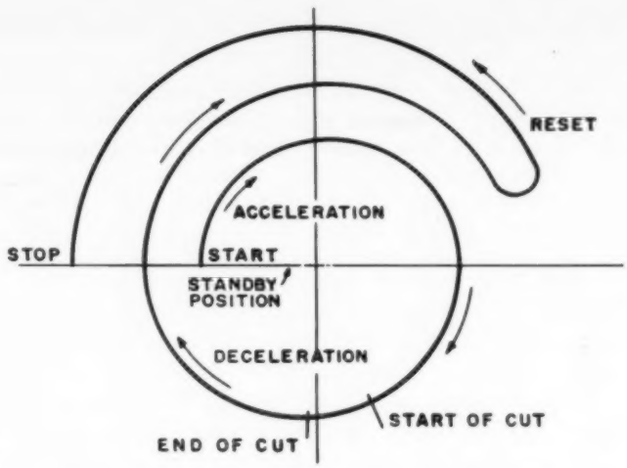


Figure 7—Sketch shows shear cut cycle development.

The time allocated to resetting is usually double or triple the combined time for accelerating, cutting and decelerating. This, however, represents a very small portion of the complete cycle time, even when one shear covers as many as three pass lines.

One other special function that the control system can provide to make the shear duty cycle less severe is to supply continuous over-excitation of the motor fields. This has the benefit of increasing the torque constant of a given shear motor with only a minor increase in the over-all rms heating. By increasing the motor torque constant, the peak torque and the rate of rise of current may be reduced for a given duty cycle. In addition, any small effects of armature reaction will be made even less noticeable as a result of motor field over-excitation.

Operating times of relays can become limiting items when relays perform switching functions during the accelerate-cut-decelerate cycle. Because of short cycle times, such relay operating times must be minimized. Cam limit switch contacts have been substituted for relay contacts wherever possible to eliminate time delays.

Since relays in a shear control circuit can be called upon to operate quite frequently, it is expected that static switching circuits will be applied to these applications. Frequency of relay operation is especially high on a cooling bed shear. This will be seen from the duty cycles illustrated later. In addition, static switching elements offer fast operating times necessary for the short operating cycles involved.

To initiate the shearing action at the proper time requires only simple control devices. On a multi-strand shear, a flag limit switch, or other suitable material detector, is used to initiate the transfer of the shear to the appropriate pass line (if necessary), and to start an adjustable timing relay which will ultimately initiate the shearing cycle. The timing interval prior to the cut cycle may be adjusted by the operator to obtain

the desired length of cropped end for a given material speed.

COOLING BED CUT-TO-LENGTH SHEARS

Considering the additional reduction of material cross section in the intermediate train, the speed of finished material will be much higher than was encountered at the delivery end of the roughing train. A start-stop cooling bed shear, which is placed at the delivery end of the intermediate train, is required to accelerate to higher speeds and, because of the higher average shear velocity during acceleration, it must accelerate within a shorter time. Both of these factors, namely higher ultimate speed and shorter accelerating time, tend to make the cooling bed shear cycle more strenuous than crop and cobble shear cycles. The smaller material cross section does, however, permit the use of a shear of lower inertia, which lessens the accelerating torque required. Although it might be thought that the smaller cross sectional area at the delivery end of the intermediate train might increase the available accelerating angle, this is not necessarily true when rolling merchant shapes such as angles.

Operational requirements—The cooling bed shear is used to cut finished rods or bars "on the fly" into suitable lengths for handling in the cooling bed. The shear does not make a crop cut on the front end of the material, nor does it perform continuous cobble cutting.

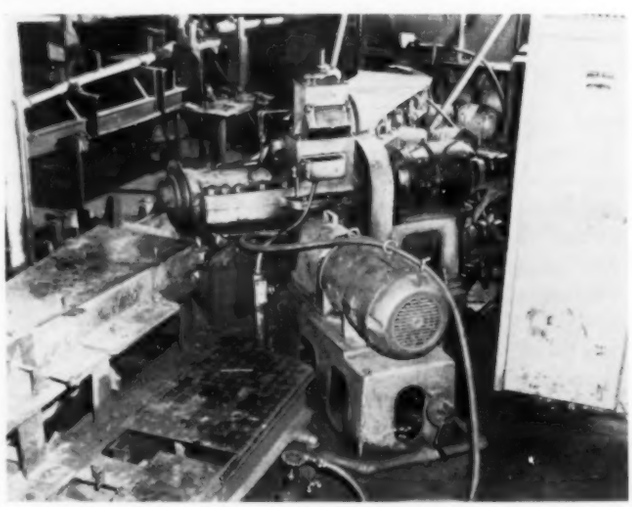
Two basic types of shear have been used frequently in modern installations. Both of these are d-c electric driven, although only one of them operates on a start-stop cycle.

Rotary-disk shear—The rotary disk shear shown in Figure 8 consists of two disks rotating continuously at an adjustable preset speed. A start-stop cycle is not required. Material is passed between the two disks in order to accomplish the shearing operation.

The material traveling at a normal velocity enters a movable trough before it passes the shear. The trough is moved laterally at an equal velocity to actuate the shearing action. The resultant velocity of the material during the cut is therefore 1.4 times material speed and is oriented at 45 degrees with respect to the direction of material flow. The axis of each disk is located at right angles to this resultant velocity, and the speed of the periphery of each disk is adjusted to 1.4 times material speed. Thus, the linear velocity of the cutting edge of each disk matches that of the material. In practice, the normal velocity of the trough is not changed for a change in material delivery speed although the speed of the disk is adjusted with material delivery speed. This results in a mismatch between the linear velocity of the material and that of the cutting edge of each disk; this mismatch does not usually present any great difficulties.

After a cutting operation, the material runs past a

Figure 8—Disks on rotary disk cut-to-length shear must be separated in order to permit returning the material to the front side of the shear.



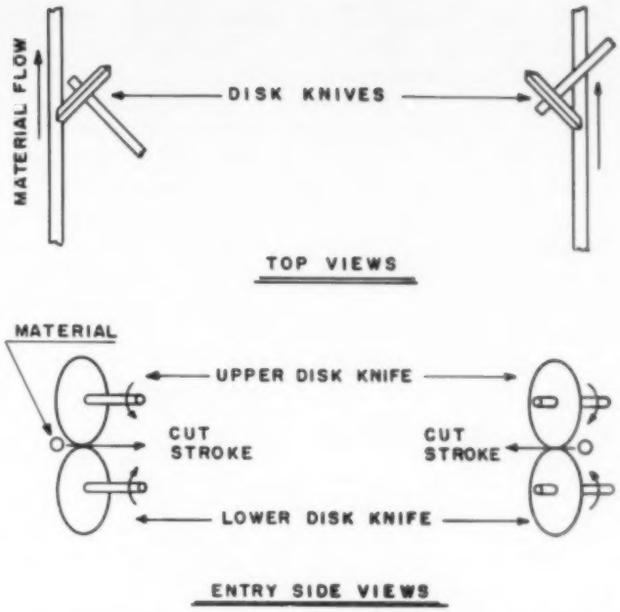


Figure 9—This rotary disk shear has transferable shear carriage.

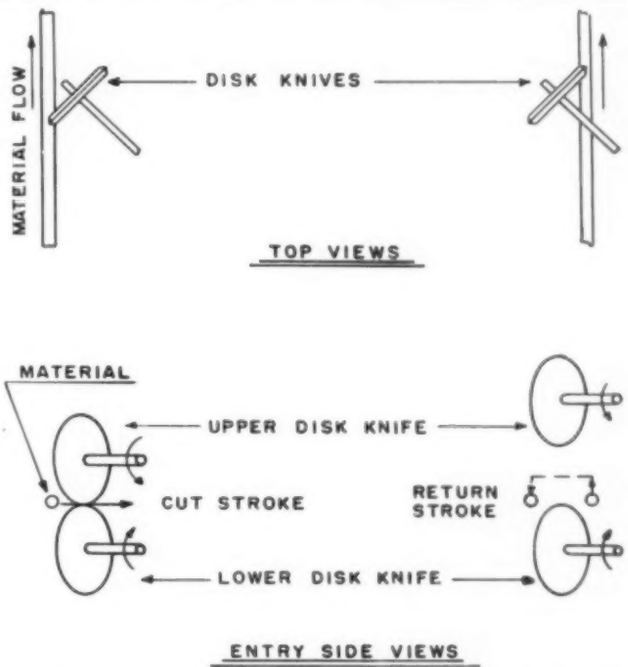


Figure 10—This rotary disk shear has separable disk knives.

shear on its "backhand" side. Either the shear must be reoriented with respect to the material flow as shown in Figure 9 in order to prepare for the next cut, or the material must be returned to the "fronthand" side of the shear with the disks separated as shown in Figure 10.

The arrangement shown in Figure 9 is ideal for use with a double cooling bed where successive cut lengths of material are delivered to different cooling beds. The shear is mounted on a carriage which rotates the shear through a 90-degree angle. No disk separating means is required, nor is it necessary to operate the shear crop for non-cutting strokes.

The arrangement shown in Figure 10 is usually used with a single cooling bed. An eccentric drive is used to separate the disks.

The kinetic energy of the rotating parts of the shear provides most of the shearing force required. Rotary disk shear motors are generally selected to provide slightly more than the friction horsepower of the shear over the entire range of material speed. The field weakening range of the adjustable speed d-c motor is normally used to cover the range of material speeds. Armature power for the motor is obtained from a constant potential d-c source through a non-reversing, dynamic braking, magnetic control.

Rotating drum shear—The relatively small cross sections of most finished bars and rods eliminate the need for special mechanisms to provide relatively linear knife motion during the cut. Therefore, a shear having a circular knife travel, such as one with knife blades affixed to the peripheries of two rotating drums, would be satisfactory; thus the name "Rotating Drum Shear." A shear of this type is shown in Figure 11. The circular path of the edge of the knife blade readily can be visualized.

The operation of this shear is very similar to that of the electric driven crop and cobble shear. Its basic functions are:

1. Start-stop cycle, including a reset cycle to give the largest possible angle for acceleration and deceleration.

2. The extreme requirements for accelerating and decelerating torques.

Figure 11—Rotating drum cut-to-length shear is used for cutting rounds, flats, and angles (with special knives). Motor drives lower shaft extension shown in center.

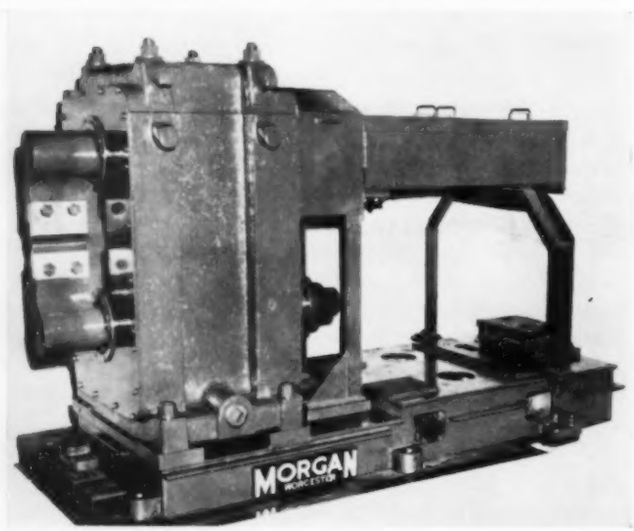


TABLE III

Electric Cooling Bed Cut-to-Length Shear

I.	**Shear data**		
	Material speed, maximum fpm		2000
	Shear accelerating angle, revolutions		0.695
	Knife travel circumference, ft		6.54
	Inertia, including gear, referred to motor shaft, lb-ft²		130
	Gear ratio		1:1
II.	**Motor, brake, and coupling data**		
	Motor selected: AISE frame 612, 75 hp, 515 rpm, 230 volts d-c, shunt-wound		
	Motor full load torque rating, lb-ft		2530
	Motor counter emf constant, at rated field excitation, volts per rpm		0.418
	Inertia referred to motor shaft, lb-ft²		
	Motor, with armature fan	123	
	Brake wheel, 10-in.	4	
	Coupling (estimated)	5	132
III.	**Calculations of average accelerating torque**		
	Total inertia, lb-ft²		262
	Maximum linear knife speed (assume 110 per cent of maximum material speed), fpm		2200
	Maximum motor speed, rpm		336
	Motor accelerating angle, revolutions		0.695
	Average motor accelerating rate, rpm per sec		1350
	Total accelerating time, sec		0.248
	Average accelerating torque, per unit		1.51
	Motor voltage at maximum speed, volts		155
	Overload torque rating of motor, frequently repeated at 155 volts, per unit		3.40

3. The type of control system, namely adjustable voltage d-c.

4. The initiation of the cut cycle from a flag limit switch, or other device.

These are all essentially the same as found with the crop and cobble shear.

When cutting minimum cooling bed lengths at maximum material delivery speeds, the start-stop cycle may repeat as often as once every six seconds. For this reason, rms heating may become an important factor in the selection of electric system capacity.

Typical data and approximate calculations for a modern cooling bed cut-to-length shear are given in Table III and Figure 12. The calculations resulted in a computer study because of the high average and maximum accelerating torques, the high rates of rise of armature current, and the short accelerating time of 0.248 sec.

An approximate rms heating calculation is shown in Figure 12. Although the rms heating obtained is well within the rating of the selected motor, providing it is forced ventilated, the computer will be used to check this result. The computer circuits may be arranged to give an integrated value of current squared.

Two of the many curves resulting from a computer study are shown in Figure 13. The armature current curve defines the maximum armature current and the maximum rate of rise of current that must be commutated successfully by the generator and the shear drive motor in order to meet the required shearing cycle. The design constants of a special d-c generator equipped with laminated shunt field poles, and a low voltage shunt field, combined with a special control system, were factored into the study. The computer study indicated that this special equipment could be applied to the shear drive in question.

The shear studied in Figure 13 has been installed and is operating successfully.

Material detection—Unlike crop and cobble shears, bed shears utilize material detectors located on the

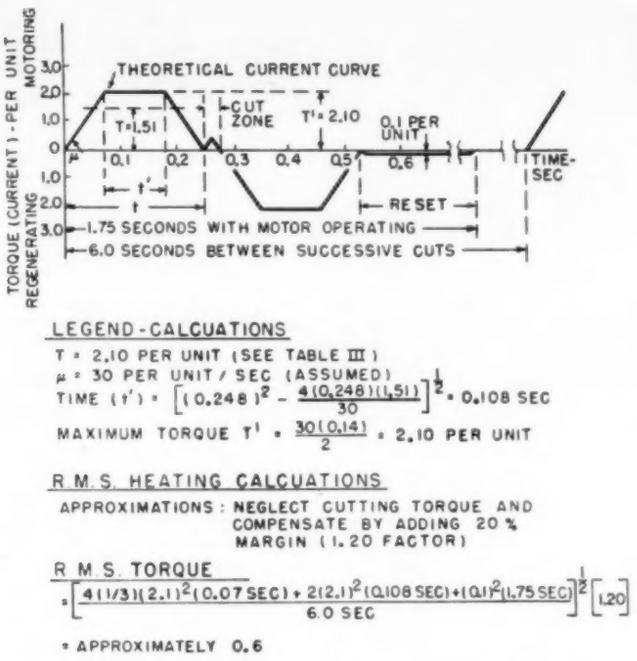

TORQUE (CURRENT) - PER UNIT
MOTORING
REGENERATING
THEORETICAL CURRENT CURVE
CUT ZONE
T=1.51
T'=2.10
0.1 PER UNIT
TIME-SEC
RESET
1.75 SECONDS WITH MOTOR OPERATING
6.0 SECONDS BETWEEN SUCCESSIVE CUTS
LEGEND - CALCUATIONS
T = 2.10 PER UNIT (SEE TABLE III)
μ = 30 PER UNIT / SEC (ASSUMED)
TIME (t') = $\left[(0.248)^2 - \frac{4(0.248)(1.51)}{30}\right]^{\frac{1}{2}}$ = 0.108 SEC
MAXIMUM TORQUE T' = $\frac{30(0.14)}{2}$ = 2.10 PER UNIT
R.M.S. HEATING CALCUATIONS
APPROXIMATIONS: NEGLECT CUTTING TORQUE AND COMPENSATE BY ADDING 20 % MARGIN (1.20 FACTOR)
R.M.S. TORQUE
= $\left[\frac{4(1/3)(2.1)^2(0.07\ SEC) + 2(2.1)^2(0.108\ SEC) + (0.1)^2(1.75\ SEC)}{6.0\ SEC}\right]^{\frac{1}{2}}$ [1.20]
= APPROXIMATELY 0.6

Figure 12—Maximum and rms torque calculations for cooling bed cut-to-length shear.

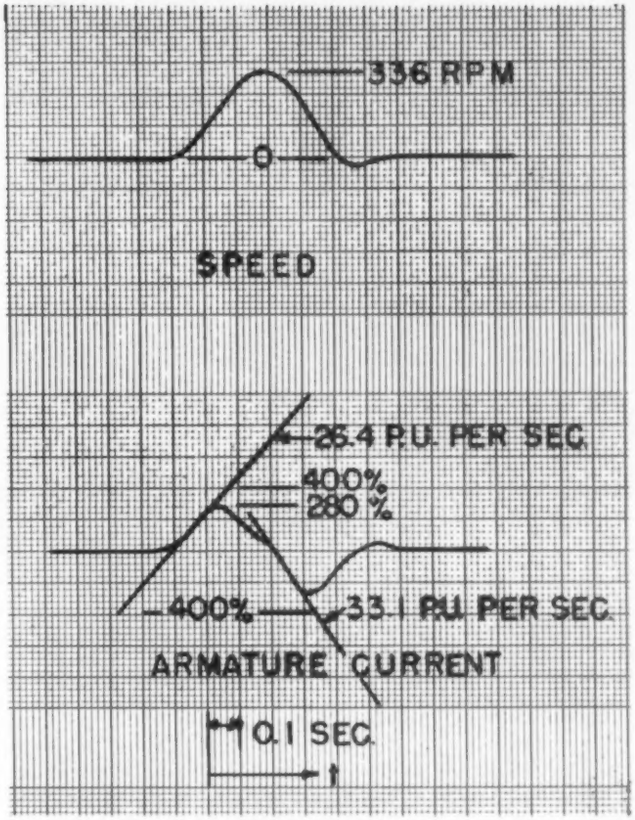


Figure 13—Results given by computer study on cooling bed cut-to-length shear.

cooling bed side of the shear. Several detectors such as flag limit switches, infrared sensitive photoelectric relays, or insulated rollers, are spaced along the cooling bed. The spacing is to provide rough adjustments of the lengths to be cut. Vernier adjustment of cut length is made through an adjustable timing relay, just as the length of crop end was adjusted for a crop and cobble shear.

Actuation of the material detector starts the adjustable timer which in turn actuates the start cycle of a drum shear, or the shear trough of a disk shear.

The rolls of the cooling bed run-in table are set to run the material faster than the exit speed of the material from the finishing stand. This is done to develop a gap separation between the back end of the cut length and the front end of the new material, in order to permit the material detector and the timer to reset preparatory to the next cut. The reset function of the detector must be very rapid, considering that a gap separation of five feet with an incoming material speed of 2500 fpm results in a reset time of only 0.12 sec.

In order to prevent difficulties in resetting the timer within the very short gap interval, the timer is reset as soon as it has initiated the shearing cycle. The need for an accurate timer will be appreciated when it is considered that with a material speed of 2500 fpm, an error of 0.12 sec will result in an error of five feet in the cut length. Best repetitive accuracy can be obtained by placing the material detector just short of the desired length of cut. This leaves the shortest possible timing interval, and should give the best timing accuracy.

Since it is much easier to handle extra long sections of material on the cooling bed than it is to dispose of extremely short lengths, it is often desirable to install an extra material detector on the entry side of the shear. This detector will prevent the operation of the shear if the detector is not covered by material. Thus, if this detector is placed, let us say, ten feet ahead of the shear, no sections shorter than ten feet will be delivered to the cooling bed, although some final lengths will be almost ten feet over the selected length.

SUMMARY

In addition to providing some general information on the operation of shears for rod and bar mills, this paper has attempted to emphasize the severe operating duty that increased production rates, as evidenced by higher material speeds, can impose on flying shears. The design of a modern shear and the design of its electric drive must be balanced carefully to obtain optimum performance from the shear at these high speeds. This calls for full coordination between the mill builder and the electrical manufacturer in the early design stages when the basic characteristics of the equipment are being determined, especially when time is required to determine realistic data for a computer study. It is hoped that this paper will create a better appreciation of the problems involved in the design of shears for rod and bar mills and will thereby promote closer coordination among the purchaser, mill builder, and electrical manufacturer.

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Y. S. & T. Puts New No. 2 Tin Mill in Operation at Indiana Harbor Works

▲ No. 2 tin mill of the Youngstown Sheet and Tube Co.'s Indiana Harbor Works at East Chicago, Ind., the latest facility in the company's broad expansion program, features advanced engineering techniques for cleaning, annealing, preparing, temper rolling, electrolytic plating shearing, assorting and shipping of tin plate.

Coils which have been hot rolled from slabs in the 54-in. hot strip mill and cold reduced to tinplate gages on the 5-stand cold reduction mill at No. 1 tin mill or on the 4-stand cold reduction unit in the sheet mill, enter the new tin mill in the cleaning department, where electrolytic cleaning equipment processes the strip at 2500 fpm.

This department also houses a continuous annealing furnace, the first unit of this type in any of Youngstown's operations. Strip can be moved through this furnace at 500 to 750 fpm. Gas-fired portable annealing covers are also provided for batch annealing.

The strip is then rolled through the temper mill at speeds up to 6000 fpm. This mill consists of two 4-high stands.

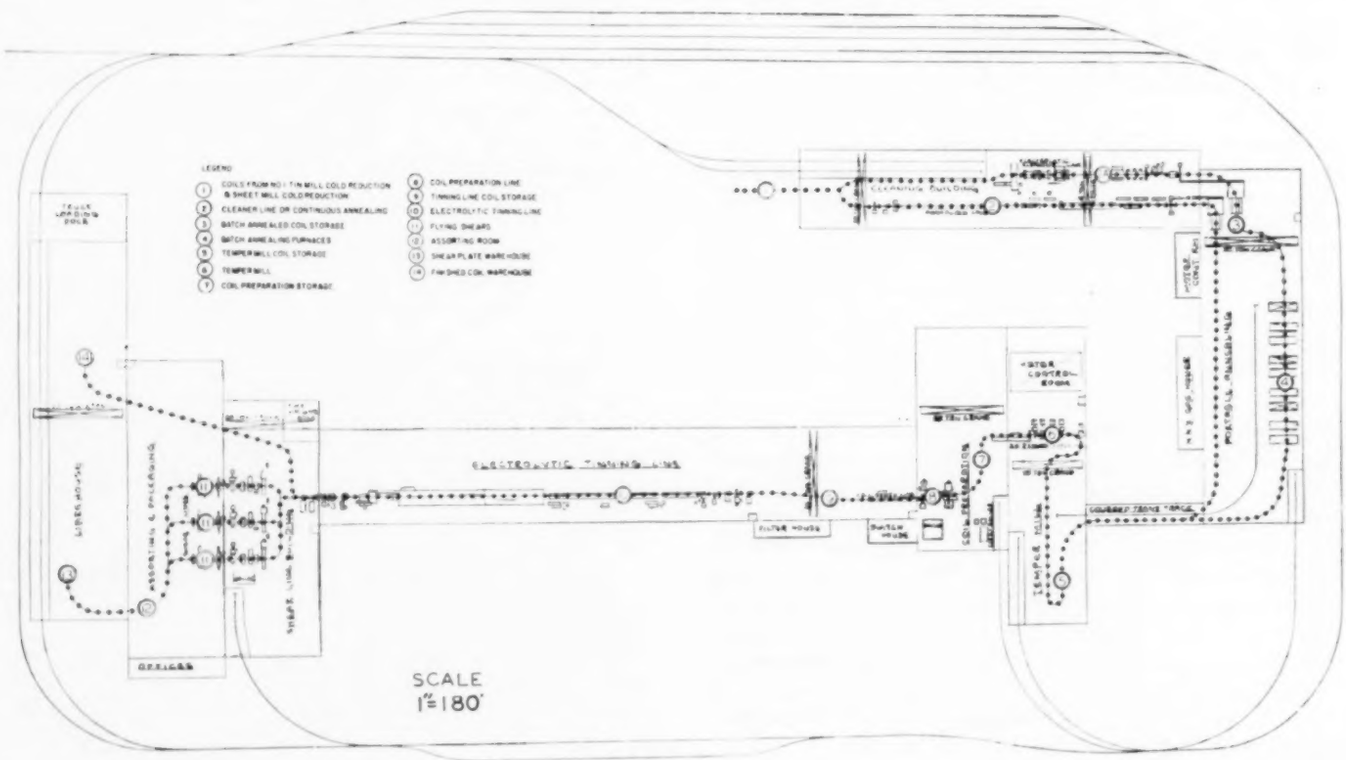
Each stand of the mill is driven by the 52-in. by 56-in. bottom backup roll, with the result that drive speeds are relatively slow (of the order of 400 rpm), even at the maximum mill speed. This gives smooth operation.

The temper mill stands are heavily motored, with a 1250-hp drive on No. 1 stand and a 1500-hp motor on No. 2 stand.

At the coil preparation unit the strip is trimmed to specified widths and recoiled at the rate of 4000 fpm.

Entering the electrolytic tinning line, strip is first electrolytically cleaned with an alkaline solvent, scrubbed, pickled, scrubbed and cleaned again in an alkaline bath. The tinning section consists of three horizontal passes, the first two of which contain 32 plating cells, each powered with a 9000-amp, 20-volt generator. In the bottom pass, strip is coated on the bottom side. The course of the strip is then reversed

Figure 1 — Diagram shows flow through new No. 2 tin mill.


LEGEND
1 COILS FROM NO. 1 TIN MILL COLD REDUCTION & SHEET MILL COLD REDUCTION
2 CLEANER LINE OR CONTINUOUS ANNEALING
3 BATCH ANNEALED COIL STORAGE
4 BATCH ANNEALING FURNACES
5 TEMPER MILL COIL STORAGE
6 TEMPER MILL
7 COIL PREPARATION STORAGE
8 COIL PREPARATION LINE
9 TINNING LINE COIL STORAGE
10 ELECTROLYTIC TINNING LINE
11 FLYING SHEARS
12 ASSORTING ROOM
13 SHEAR PLATE WAREHOUSE
14 FINISHED COIL WAREHOUSE
SCALE
1"=180'

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BAR and ROD MILLS

4-way example of service to the Steel Industry by

The Rust Engineering Company and Subsidiary Companies

Rod Mill in operation. All machinery, equipment and utilities installed by Rust personnel.

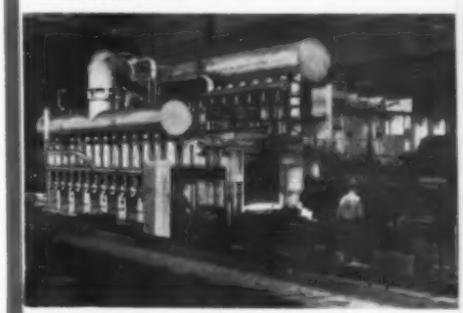
21-Stand, 13" Combination Merchant Bar and Rod Mill Building, designed and constructed for ATLANTIC STEEL COMPANY, Atlanta, Ga.

Helping Atlantic Steel Company fulfill its expansion plans for additional facilities to increase production, The Rust Engineering Company and Subsidiary Companies completed the following contracts, in providing this efficient new mill:

1. **DESIGN AND CONSTRUCTION** Building facilities for this combination merchant bar and rod mill were designed and constructed by The Rust Engineering Company The plant is completely new.
2. **MACHINERY INSTALLATION** All machinery, auxiliary equipment and utilities were installed by The Rust Engineering Company.
3. **ELECTRICAL INSTALLATION** Electrical work was handled by Allegheny Industrial Electrical Company, Inc.
4. **REHEATING FURNACE** The double-fired, zone controlled, recuperative, continuous reheating furnace was designed, built and installed by Rust Furnace Company.

This modern mill has a maximum speed of 5,000 feet per minute for rods, and a production rate of 50 to 70 tons per hour for merchant products. The mill produces rods, rounds, flats, angles, and light beams of various sizes.

Motor Room of new Mill. All electrical installations by Allegheny Industrial Electrical Co., Inc.



Reheating Furnace for 13" Mill — designed, built and installed by Rust Furnace Company.

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up through the second pass, where it is coated on the other side. The strip again is reversed to its original direction to be rinsed and dried.

The strip then passes through a high-frequency induction reflow unit and is then chemically treated, oiled and recoiled.

The new line is capable of differential coating. Thicknesses ranging from one-quarter pound per base box to one pound can be applied. Halogen electrolyte is used.

The shear lines, of which there are three in the new mill, have cutting speeds up to 1250 fpm. They are equipped with x-ray gages, pinhole detectors and classifiers to separate primary and secondary grades of sheets. Each mechanical assorter is also equipped with an automatic classifying device.

Conveyors, cranes and tractors are used to handle the coils in the mill. Tin plate is shipped from the mill warehouse shipping department by rail or truck.

Alternate overhead units of mercury and incandescent lights produce a white light, considered most desirable for industry work areas.

Figure 2 — In another of the steps before tinning, the strip is temper rolled on this modern, two-stand, 6,000-fpm mill.

Modern locker rooms and welfare facilities are provided for employees.

The mill is made up of eight connected buildings covered 419,655 sq ft on what was once a lake. Ground was broken May 17, 1955, and the tinning line went into commercial operation on May 1, 1957.

Acme Steel Breaks Ground for New Steelmaking Plant

▲ GROUND was broken on July 22 in Riverdale, Ill., for Acme Steel Co.'s new $23,000,000 steelmaking plant, which will introduce to this country a new process in steel production, the combination of hot blast cupolas and oxygen blown converters.

A group of five buildings will contain the process. These buildings will be arranged in 80-ft bays about 550 ft long covering approximately three and a third acres under roof. Housed in these buildings will be two iron producing cupolas which will consume steel scrap, pig iron, coke and limestone and will produce 1200 tons of iron per day. The molten iron produced in them will then be charged in two oxygen-blown convertors, each of which can take 50 tons of iron at a time, and which will convert 50 tons of iron into steel in about 35 minutes.

Oxygen will be supplied by an air separation plant to be built on the property, which will provide 110 tons of oxygen per day. The rest of the buildings on the North end of the peninsula are required for the assembly of raw materials that go into the process and for pouring.

A second group of buildings will be spaced somewhat apart and south of the steelmaking area. These will run about 1300 ft in length and about 275 ft at their widest point comprising approximately four acres under roof.

In these buildings will be the ingot heating furnaces where ingots will be reheated for rolling in the blooming and billet mills.

The blooming mill will roll an ingot about two ft square and about eight ft tall into a bloom about seven by six in. for further rolling in the billet mill which will follow in direct line. It will also roll wider slabs used as raw material in the present rolling mills at Acme Steel.

The billet mill, will roll down to sizes as small as 1¾ in. square without reheating.

The initial capacity of the steelmaking plant, which will be completed late in 1958, is planned for 450,000 ingot tons annually which will provide 70 per cent of Riverdale's requirements of billets and slabs. The rolling equipment will have capacity substantially in excess of this figure. The construction cost of these facilities is estimated at $51 per annual ingot ton. Plant design and engineering have taken into consideration the eventual enlargement to increase ingot capacity sufficient to provide the Riverdale plant with its entire steel requirements.

Koppers Starts West Virginia Plant

▲ A new plant designed to upgrade certain of the high boiling chemicals that are constituents of coal has been completed by the Tar Products Division of Koppers Company, Inc. Located at Arroyo, W. Va., the plant will be used for the production of niacin and in development work on production techniques and applications for certain coal tar chemical fractions.

While the new plant presently occupies only four acres of ground, Koppers has purchased approximately 285 acres of ground at the Arroyo site in view of long-range plans for expansion of the new installation.

NIACIN PLANT

Niacin—or nicotinic acid—is one of the B complex vitamins and is used as a supplement for the enrichment of feed and food, and for pharmaceuticals. The raw material from which it is produced is quinoline, a coal tar product presently produced and supplied from Koppers' tar product plant at Follansbee, W. Va.

Present plans call for production of two grades of niacin at the Arroyo plant: a feed grade for animal nutrition; and a U.S.P. grade for enriching certain human foods and for use in certain pharmaceuticals.

All of the equipment in which the materials are processed or transported is made either of stainless steel or glass. Formulation of the process materials is under continuous check through a system known as "metering to-and-thru" in order to assure complete purity and uniform potency. Process water used in this plant is brought to a purity surpassing that of distilled water by means of an ion exchange purifying system. The packaging operation, during which the niacin is exposed for the first time, is conducted under controlled conditions of atmospheric pressure, temperature, and humidity.

DEVELOPMENT PLANT

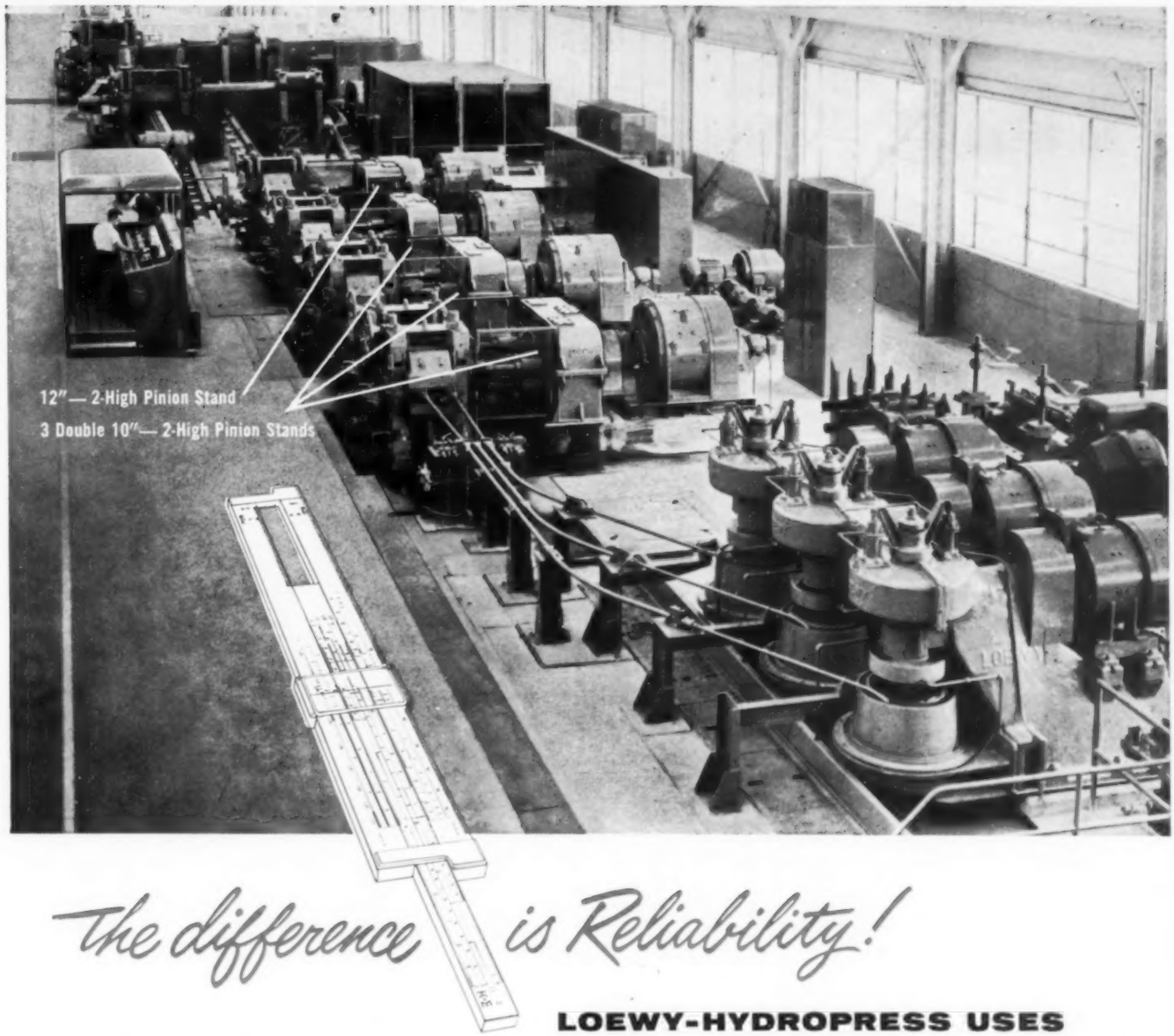
The development plant is the result of experimental work and planning by the central staff research department and the development section of the Tar Products Division. It has been designed as a group of basic units for conducting distillation and crystallization processes utilizing high-boiling (above 500 F) coal tar chemicals. At the same time it has been visualized as the nucleus for further process equipment which will be added as time and the progress of particular developments dictate.

A primary consideration in the location of the plant was that it would be near substantial sources of coal tar for utilization as raw material in the future. Initially, the plant will utilize creosote, produced at the Follansbee plant, as a raw material.

From the creosote, or other coal tar fractions, it is hoped that economical means can be found to separate the principal coal tar chemicals. It is proposed to give attention first to the separation of phenanthrene, anthracene and carbazole, which are the largest fractions contained in creosote, and to find practical uses.

One of the supplemental benefits to be realized through the work at this plant is that the creosote from which these three cuts have been removed will actually be a superior creosote. This is because these three chemicals add nothing to the physical properties of the creosote. In fact, because of their tendency to crystallize under certain conditions, they have proved troublesome in certain pressure treating and handling operations.

Figure 1 — This aerial view shows the compactness that is a feature in the design of the new niacin and development plant of Koppers Tar Products Division at Arroyo, W. Va. Although the fenced-in area shown here comprises only about four acres, some 285 acres are held by Koppers at the site for future expansion.



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Typical Western Gear pinion stand, available in capacities to 2000 HP.

When the Loewy-Hydropress division of Baldwin-Lima-Hamilton Corporation designed and built an important installation for a leading manufacturer of electric cable, they selected Western Gear pinion stands. Company engineers knew that our years of experience and service to the steel industry would result in units engineered to suit the specific requirements of power and speed, type and gauge of metal, nature of load, and type of drive motor. Western Gear pinion stand designs incorporate special "Hy-Q"* precision gears and pinions, liberal size shafts, conservatively selected anti-friction bearings, and rigidly constructed gear cases in order to insure dependable trouble-free operation.

So, if yours is a project involving modernization or the construction of a new mill, ask Western Gear specialists to help you. You'll get the benefit of mechanical power transmission experience gained since 1888 to help solve your problem, efficiently and economically. Address General Offices, Western Gear, P.O. Box 182, Lynwood, California.

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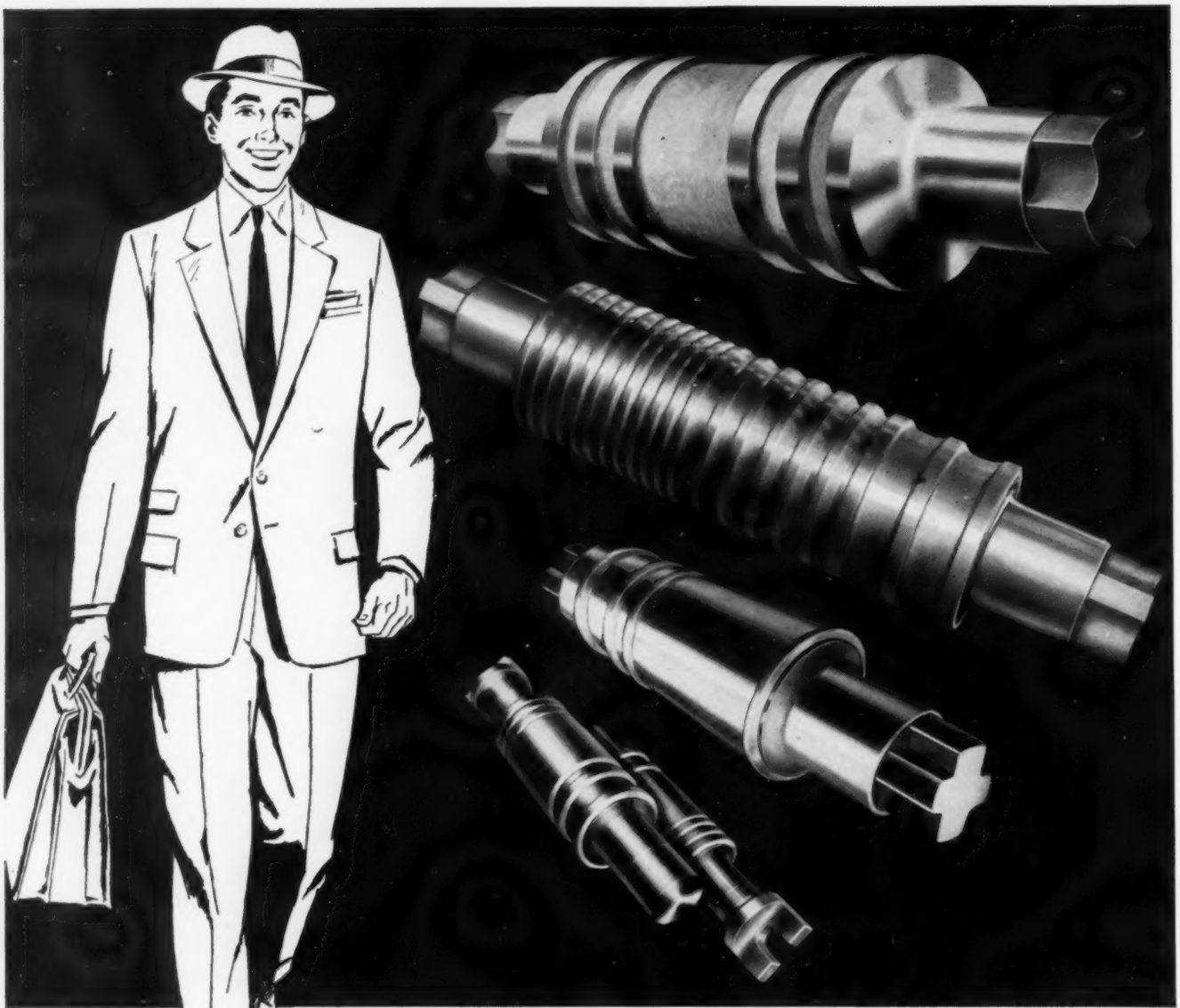

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Three-Hose Scarfing Torch Permits Independent Preheating and Scarfing Oxygen Flow

▲ A new three-hose scarfing torch (Figure 1) has been developed by National Cylinder Gas Co., Chicago, to solve classic problems in heavy duty work where large rates of metal removal are desired. It has been successfully field tested for a year now at major mills in both the Pittsburgh and Chicago areas.

It permits independent control of the preheating and the scarfing oxygen flows—a problem with existing designs which permit sudden changes in preheat flow (and altered oxygen-acetylene ratio) when the main scarfing stream is suddenly started or stopped. In removing seams, scabs, cracks or laps from billets, ingots or slabs, stability of the flow of oxygen-for-combustion irrespective of oxygen-for-scarfing becomes important.

Scarfing oxygen pressure in any torch is generally five to seven times the pressure of the preheat oxygen. Maintenance of preheat flow despite such violent changes in scarfing oxygen flow (zero to full-on and vice versa) during torch use have heretofore been ignored or accomplished through complicated valving and regulating devices in the torch. Such mechanisms increase torch maintenance and, even when operating perfectly, can only approximate the absolute independence of oxygen flows which is inherent in three-hose design.

The pressure drop diagram (Figure 2) shows the independence of the two oxygen flows all the way back to independent pressure regulators—and gives typical pressure contours to help users understand the relative effect on flow of supply hose, valves and tips. To get the most out of the scarfing dock arrangement, supervisors and operators must understand such pressure profiles.

Additional features of the new torch include: (1) an improved guard (removable and replaceable) over the head of the torch and an improved skid ring on the end of the tip—both of modern wear-resistant alloys; (2) improved balance specifically engineered for scarfing work; and (3) unusually convenient placement of scarfing lever, preheat oxygen adjustment, and acetylene valve with respect to operators' hands and stance.

The illustrated Model-33 has a maximum capacity of 6000 cfhr of scarfing oxygen at a station regulator outlet pressure of 100 psi when used with 50 ft of ½-in. hose. Tip sizes available for different classes of work are ½, ⅝ and ¾-in. (scarfing port diameter).

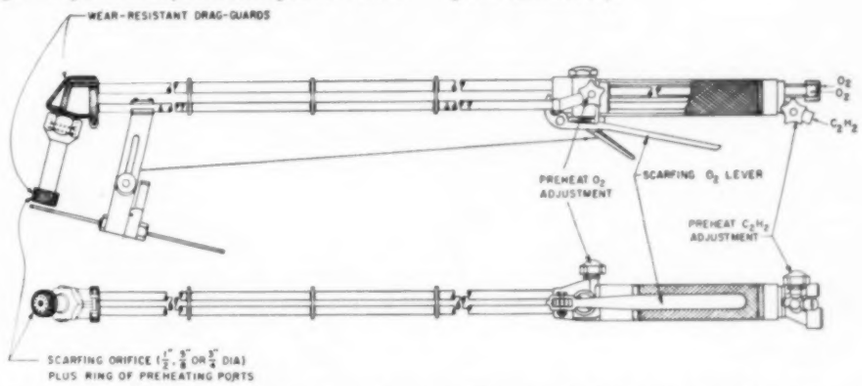
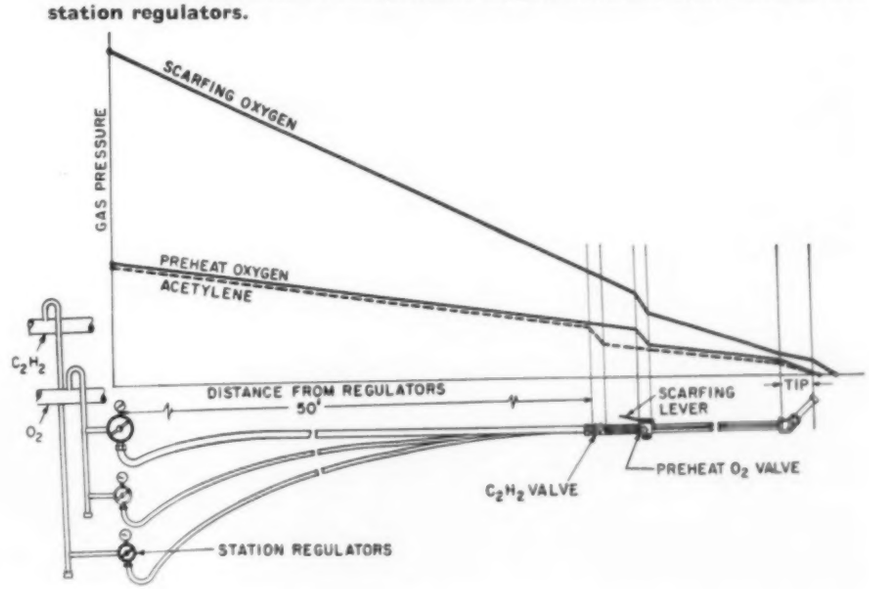


Figure 1 — The heavy duty three-hose scarfing torch (wire feed omitted from lower view for clarity) permits independent control of scarfing and oxygen flows.

Figure 2 — Typical pressure drop profile during heavy-duty three-hose scarfing shows the effectiveness of independent oxygen controls, clear back to the station regulators.



National Supply Installs Bag House for Cleaning Air

▲ A giant "vacuum cleaner" that uses 780 15-ft bags and that occupies its own four-room building has been installed at the Torrance, Calif., plant of The National Supply Co. as part of the management's continuing fight against air pollution.

The $125,000-system which serves the electric melting furnace department, is capable of moving 75,000 cfm of dust-laden air compared to 28,000 cfm moved by the system formerly used. Because of its efficiency, even the finest particles of dust are trapped, allowing only clean air to be discharged to the atmosphere.

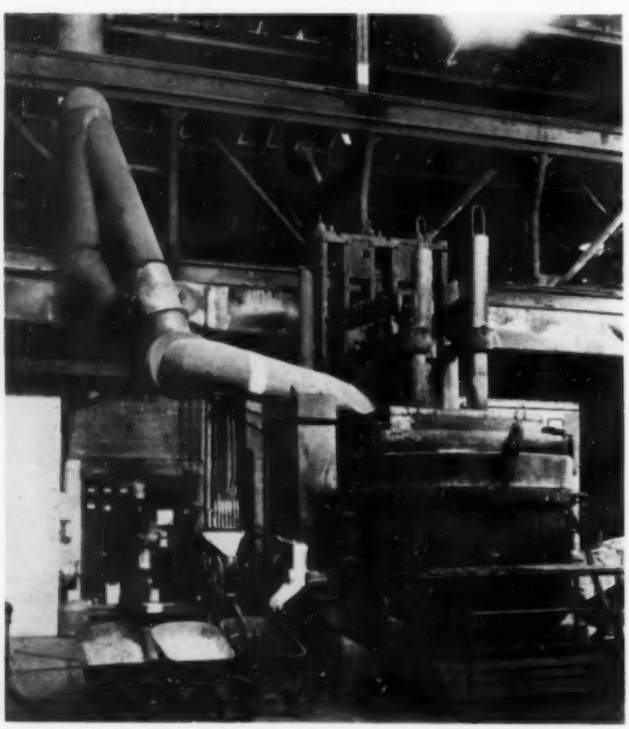
Ducts over each of the electric furnaces carry all smoke from the melting operations to a new building known as a "baghouse." In each room of four rooms in this building are suspended 195 dacron bags, 15 ft long and 6 in. in diameter. Acting much like the bags of household vacuum cleaners, these bags collect all the dust from the air that passes through them. Once an hour, one room at a time is automatically shut off from the system for ten seconds, during which the bags are shaken vigorously, causing the dust to fall from them into a collecting hopper at the bottom. From this hopper, the dust is carried by a conveyor to a discharge chute where it is mixed with water to form sludge. At intervals the accumulated sludge is hauled away to a dump.

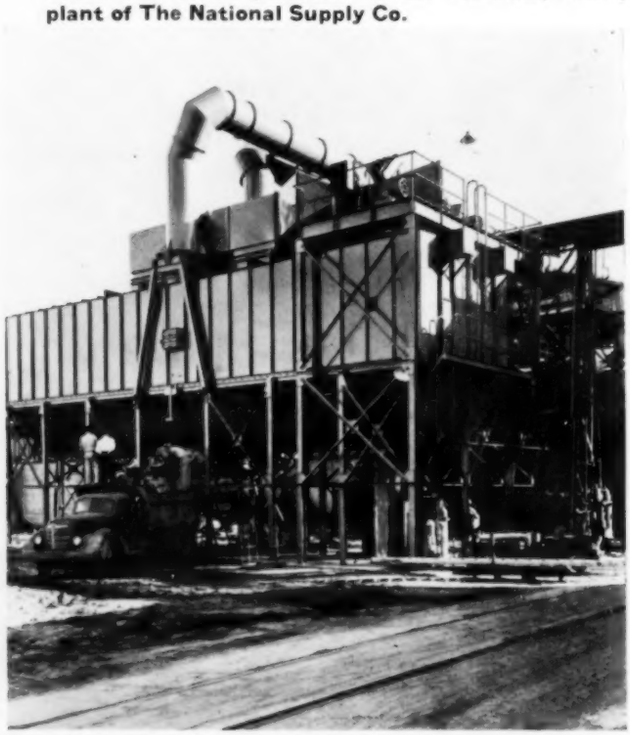
The former system used close-fitting collecting hoods mounted on top of the melting furnaces. From these hoods, the dust-laden air was carried by ducts to a large collector in which it passed through a curtain of water. Only small quantities of the finest particles of dust escaped to the air, but these caused a visible discharge that brought complaints of air pollution.

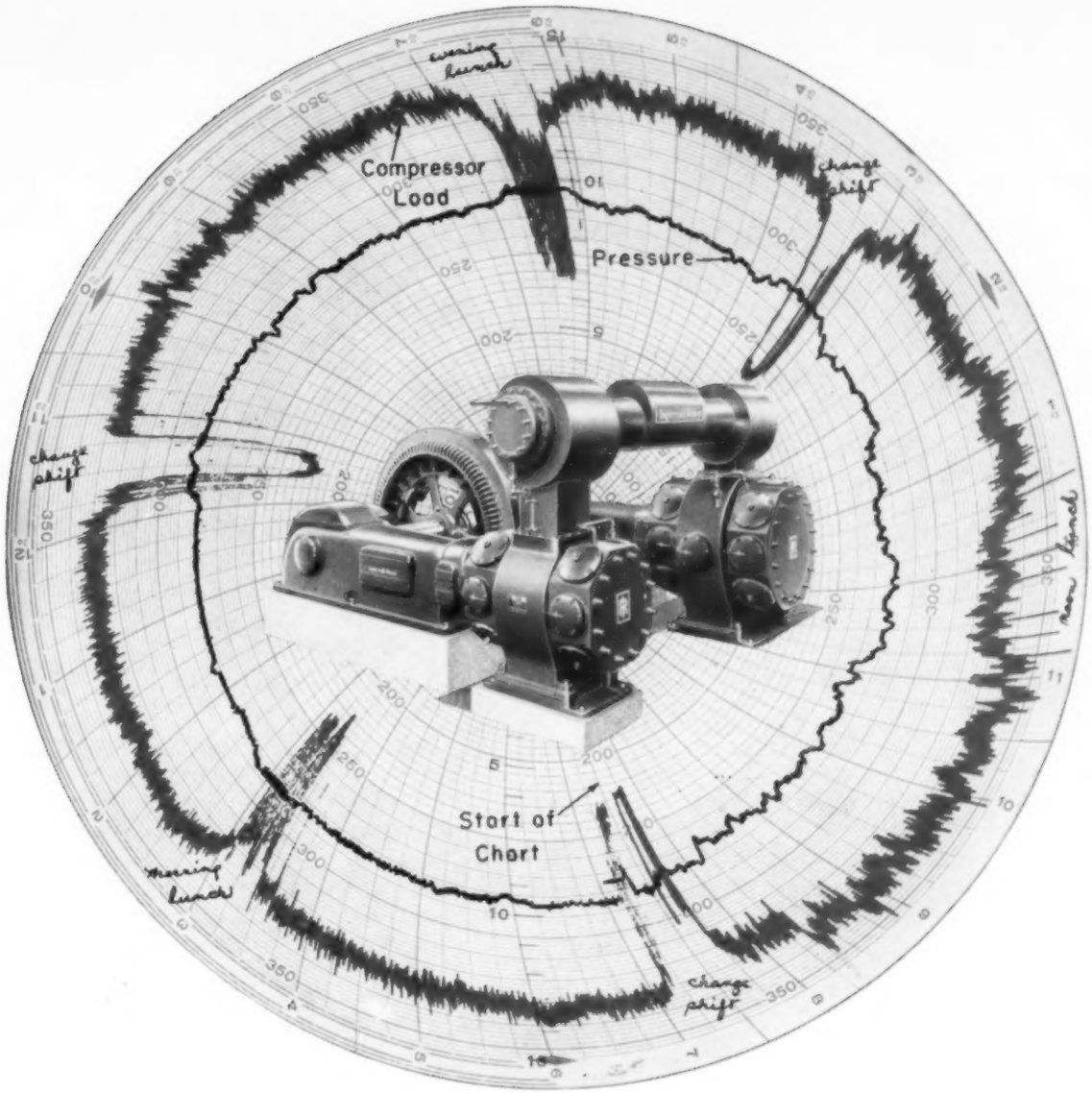
Another disadvantage of the former system was that its smaller capacity prevented collection of the quantities of smoke that result when gaseous oxygen is injected into melting furnaces. Because of this, the plant could not use the gaseous oxygen method, employed by most steelmakers, which results in greater melting efficiency. With the new system, gaseous oxygen can be used with no danger of air pollution.

The new system was engineered by the H. J. Horrell Co., Los Angeles, in co-operation with the en-

Figure 1 (left) — Ducts carry dust-laden air from the melting operations to the baghouse for cleaning. Hoods over the furnace and furnace doors collect all smoke, dust and fumes and lead them to the ducts. Figure 2 (right) — Four-room baghouse was installed as part of the war on air pollution at the Torrance, Calif., plant of The National Supply Co.







AROUND THE CLOCK

with an Ingersoll-Rand PRE Compressor

Heavy 24-hour loading like this is all in a day's work at Caterpillar Tractor Co.

An air compressor doesn't punch a time clock. But the 24-hour pressure-capacity chart shown above gives an even better record of its actual, on-the-job performance at Caterpillar Tractor Co., Peoria, Ill.

This chart was taken on a nine-year-old PRE compressor supplying 3330 cfm at 95 psi for general plant air. Except for a slight "breather" during changing of shifts, this heavy-duty compressor is called upon to deliver full rated capacity virtually 24 hours a day — month after month, year after year.

This compressor is one of eight PREs (total capacity 24,640 cfm) in round-the-clock service at the Caterpillar plant. The first PRE unit was installed here in 1927 and, like all the rest, is still giving efficient, dependable performance under full load conditions.

For proved dependability like this, in continuous heavy-duty service, it pays to specify Ingersoll-Rand compressors. Ask your I-R representative to give you the complete story.

PRE compressors, 400 to 3000 hp, use I-R Channel Valves

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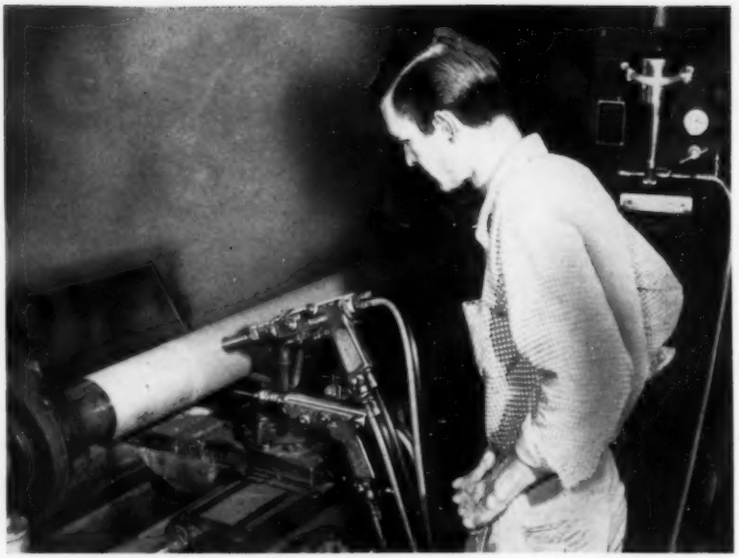
Unique Colmonoy hard-facing alloy is sprayed on in powder form



Mounted on the tool post, two Spraywelders apply Colmonoy No. 6 hard-facing alloy in an even overlay to the turning pump plunger.

Colmonoy Hard-Facing Cuts Mill Maintenance

Application of Colmony No. 6 hard-facing alloy on pump plungers used in a steel tube mill has resulted in savings of $1,200.00 a year in maintenance costs.

The pumps effected are used to provide water for cooling purposes. They pump river water containing abrasive grit, dirt, and mill scale. The plungers previously used, even those protected by chrome plating or metallizing, were scored almost immediately, and required repacking up to twice a day.

After receiving an overlay of Colmonoy No. 6, a nickel-chrome-boron alloy, these large (44-inches long, $4\frac{1}{4}$-inches in diameter) plungers served without being scored and required repacking only once every three months.

Besides the superior wear-resistant qualities inherent in this Colmonoy alloy, the basic reason for its success in wear problems of this sort is its method of application. It is sprayed on in powder form with the Colmonoy Spraywelder and then fused to the base metal afterwards. The result is a non-porous welded overlay that is very smooth and within .010" of the described diameter. Grinding time is reduced to a minimum, lowering the total reclamation cost considerably.

All fast wearing cylindrical machined parts, such as pump plungers and sleeves, valve plugs, stems, and seats, roller guides, and table roll journal sleeves are ideal parts for Colmonoy hard-facing as applied by the Sprayweld Process.

The name Colmonoy stands for a complete line of hard-facing alloys, available in many different forms. An excellent example of a Colmonoy oxy-acetylene rod application is the hard-facing of roller guides used in a large bar mill using $\frac{1}{4}$-dia. Colmonoy No. 6 rod. Maintenance records show that welding time was cut 70%, and wear life increased by using Colmonoy.

The pump plungers above have been sprayed and the overlay fused to the base metal. Note how uniform the surfaces are prior to grinding.

The long wearing qualities and ease of application make Colmonoy No. 6 hard-facing a regular maintenance procedure on these bar mill roller guides.

Write for the Colmonoy Hard-Facing Manual No. 79 for complete general information about Colmonoy. We invite you to give us the particulars about any specific case of excessive wear your equipment might be suffering.

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gineering department of the plant. The baghouse was designed by the Dracco Corp., of Cleveland.

National Supply's Torrance plant is the largest completely integrated machinery manufacturing plant in the west. It has three electric melting furnaces, with capacities up to 50,000 lb per heat, as well as a foundry, together with facilities for forging, heat-treating, plating, welding, and machining of steel, and assembly of machinery for use in the oil fields and by other industries.

The plant was established in Torrance in 1912 as that city's first industry and has grown to include 33 principal buildings on a 39-acre tract. Conscious of its responsibility to the community, the management has been conducting a war on pollution for many years. Firing controls on the steam plant, scrubbing towers on the hot acid vats, dust collectors at grinding wheel locations, combustion controls on waste incinerators, and dust collection and scrubbing towers in the foundry sand system are among the methods used.

Car Thawing Operation Handles 14 Cars Per Hour

By R. J. REED Application Engineer

The North American Manufacturing Co., Cleveland, Ohio

▲ AN oil-fired coal car thawing installation has been handling as many as 14 cars per hour for the past two winters at a large mid-western plant. The average cost of oil and labor during a complete season's operation is less than $2.30 per car for 50 and 60-ton cars. The installation consists of perforated alloy radiant tubes laid between the tracks and just outside the sides of the cars. Each tube is fired with a midget light oil burner using low pressure (20 ou per sq in.) air to atomize the oil. This unique system, employing both radiation and convection in a sturdily constructed unit that is not harmed by water and dirt falling on it, was developed by The North American Mfg. Co. of Cleveland.

The top surfaces of the 6-in. diameter by 6 ft long radiant-tubes actually glow red hot, providing a large effective radiating area to

Figure 1 — Car thawing installation at a large mid-western plant has radiant tube oil burners located between the tracks at track level and 3 ft outside each rail in an elevate position.

Figure 2 — Exterior of corrugated aluminum windbreak. Note manual air and oil valves and observation windows. Car dumping building is in background.

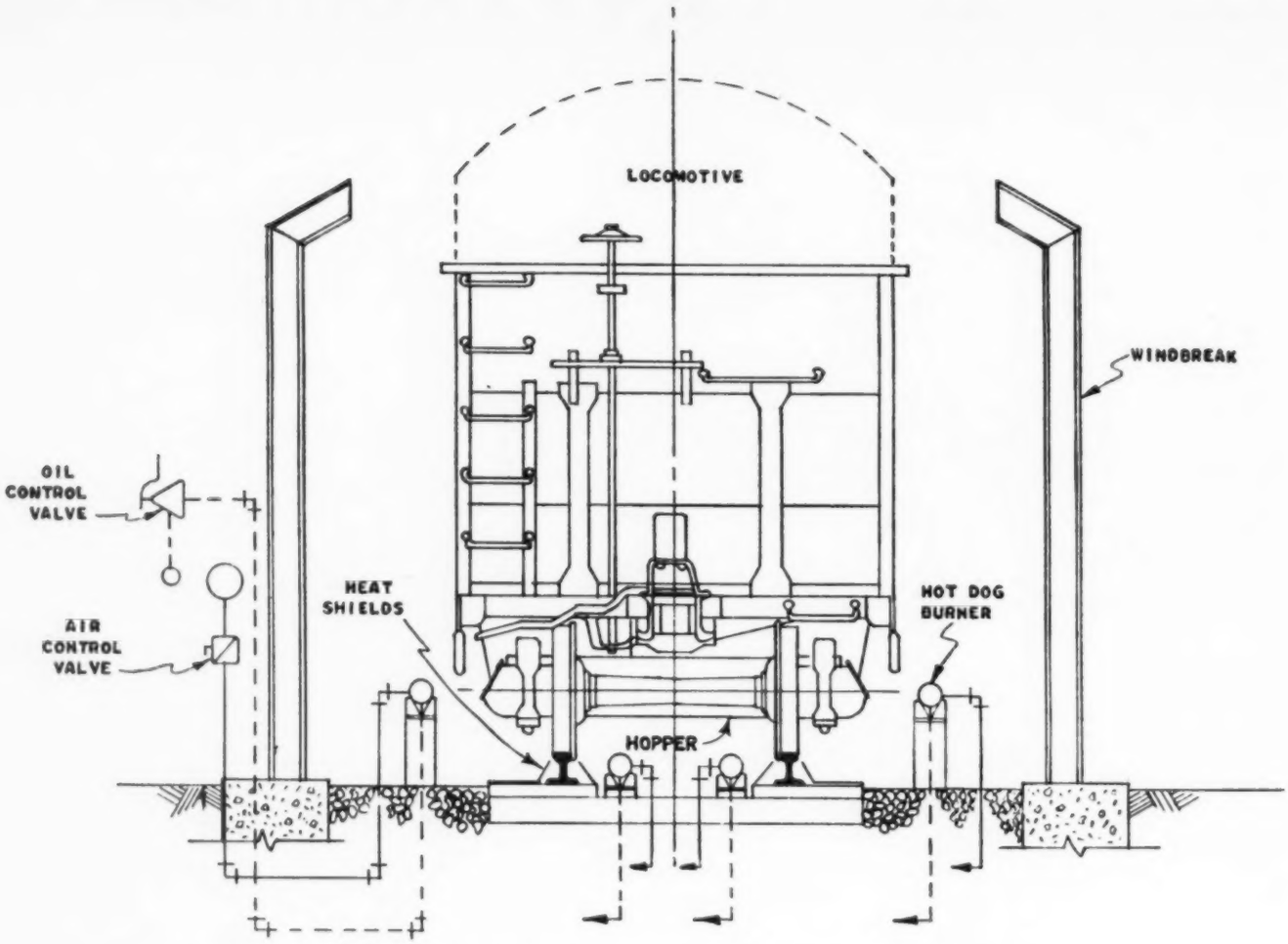


Figure 3 — Elevation view shows relative positions of burners, rails, hoppers, journals, windbreaks and controls.

transfer heat to the car hoppers and sides. In addition to this radiant heat transfer, the hot exhaust gases emitting from holes in top surfaces and end of each tube transfer heat by convection to the hopper and car surfaces, thus further utilizing the heat provided from a relatively small fuel input.

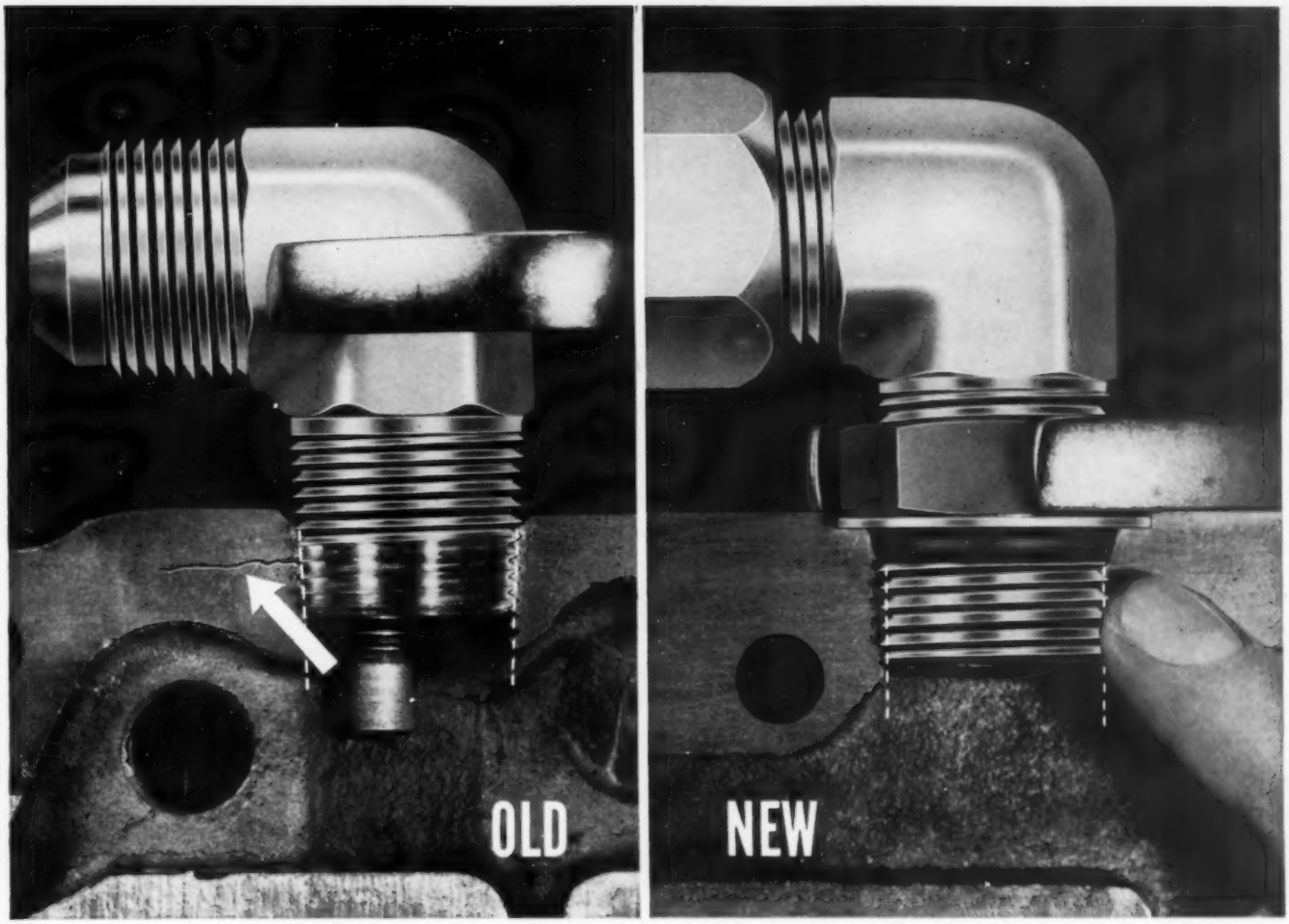
Heavy cast iron construction in the burner and tube-holding ring makes them rugged enough to withstand heat, ice, snow, water, dirt and rough handling. The stainless radiant tube is made of ⅛-in. thick super alloy containing 22 to 24 per cent chromium and 12 to 15 per cent nickel so that it can take the thermal stresses resulting from exposure to flame on the inside and dripping water on the red-hot outside surface. This tube material is highly resistant to oxidation—corrosion is not a problem.

The tube is cradled in a V-shaped support that permits the end opposite the burner to "grow" away from the burner as the tube expands. The cast iron tube-holding ring on the burner is designed to hold the burner end of the tube fixed, while still permitting easy disassembly of the tube from the burner. The perforations in the top and the orifice across the end of the tube are sized and located so as to achieve a high rate of radiation heat transfer before the gases are released for convection heating.

The radiant tube units have been affectionately dubbed "hot dogs" by the operators who are spared the dirty, dangerous job of climbing over and under coal or ore cars with torches and steam lances. The hot dogs nestled between the rails are located so that their top surface is flush with the top of the rails, but those outside the rails (5½ ft from center line) are elevated about 10 in. which adequately protects the journal boxes from the hot exhaust gases. Metal plates over insulating boards protect the ties from localized overheating.

A corrugated aluminum panel windbreak is located on each side of the tracks to conserve and localize radiant heat. An expensive completely enclosing shed is not necessary because the high temperature radiant heat is released immediately adjacent to the car hoppers and sides where it is quickly absorbed. Older installations using recirculating air heaters, steam or hot water sprays which heat solely by convection, require a shed to obtain acceptable results because of the slow rate of heat transfer realized from those low temperature methods.

The burners are lighted by a man with a torch, while another man opens the manual butterfly air valves and manual sensitrol oil valves as the torch is applied to each burner. Observation windows in the windbreak allow the two men to coordinate their operations so that they can light 52 burners in ten minutes.



How Parker straight-thread fittings solve leakage problems

Forget about danger of cracking or distorting valve bodies by overtightening the fittings. Forget about messy pipe "dope." Forget about leakage problems resulting from tapered pipe threads in high-pressure hydraulic systems.

Eliminate these problems. Use Parker O-ring seal straight-thread fittings (which conform with the SAE Standard for Hydraulic Tube Fittings) for leakproof, trouble-free connections. Available on Parker *Triple-lok* (the industrial standard flare tube fitting) and on Parker *Ferulok* (flareless fitting for heavy steel tubing).

Ask your Parker Distributor today, or mail the coupon for complete information about Parker straight-thread fittings.

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Section 436-T
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- ☐ *Ferulok* Fitting Catalog 4320
- ☐ *No-Skive Hoze-lok* Catalogs 4433 & 4434

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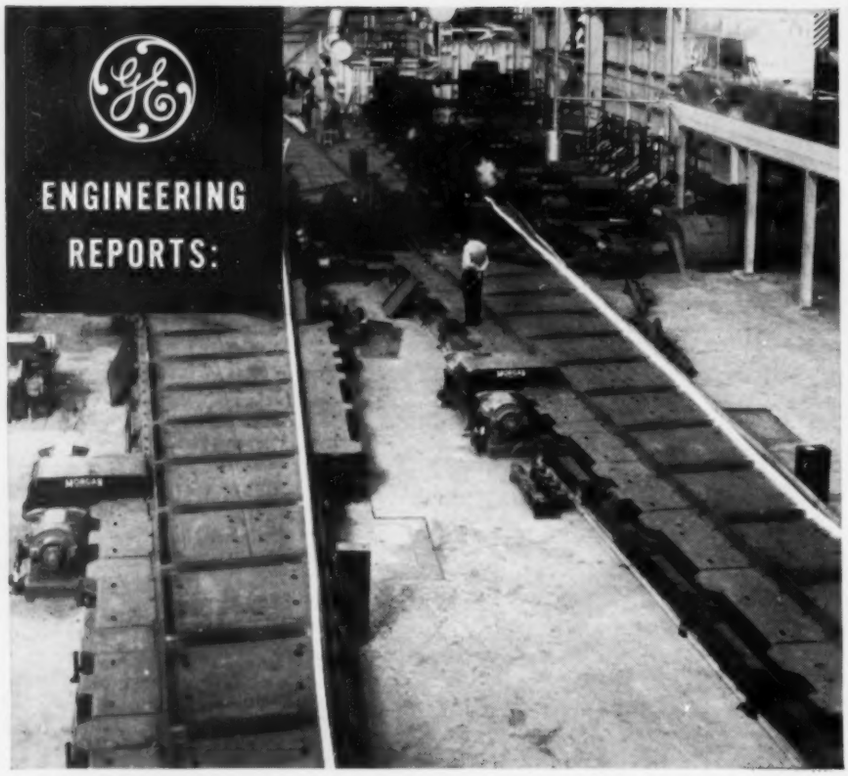
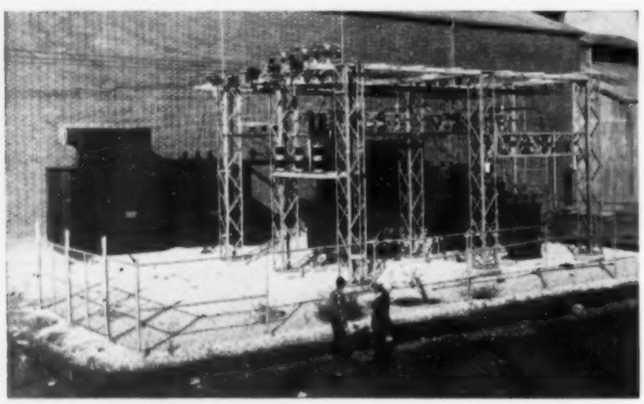
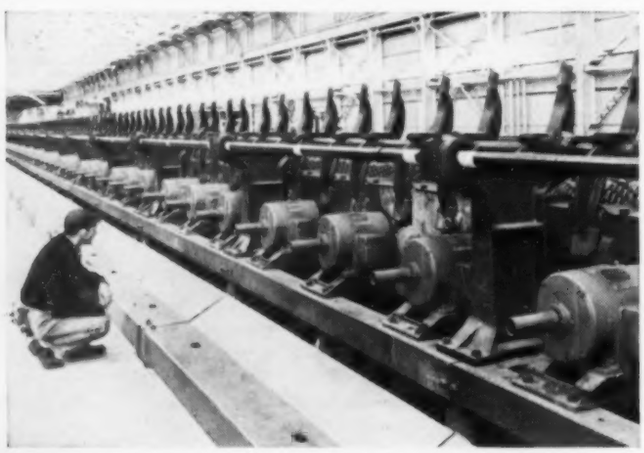


ONE OF THE FASTEST combination mills in existence, Atlantic Steel's new mill produces both rod and merchant products. Above is view of mill with skew "Y" tables in foreground.

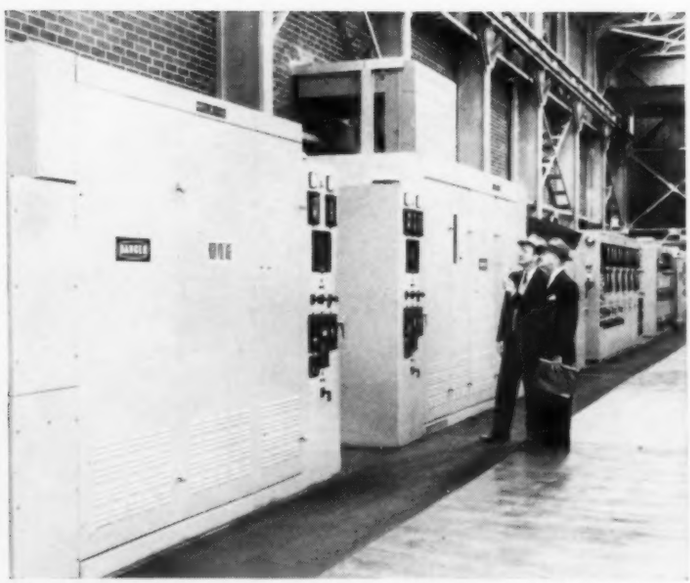
AT ATLANTIC STEEL: pulling in



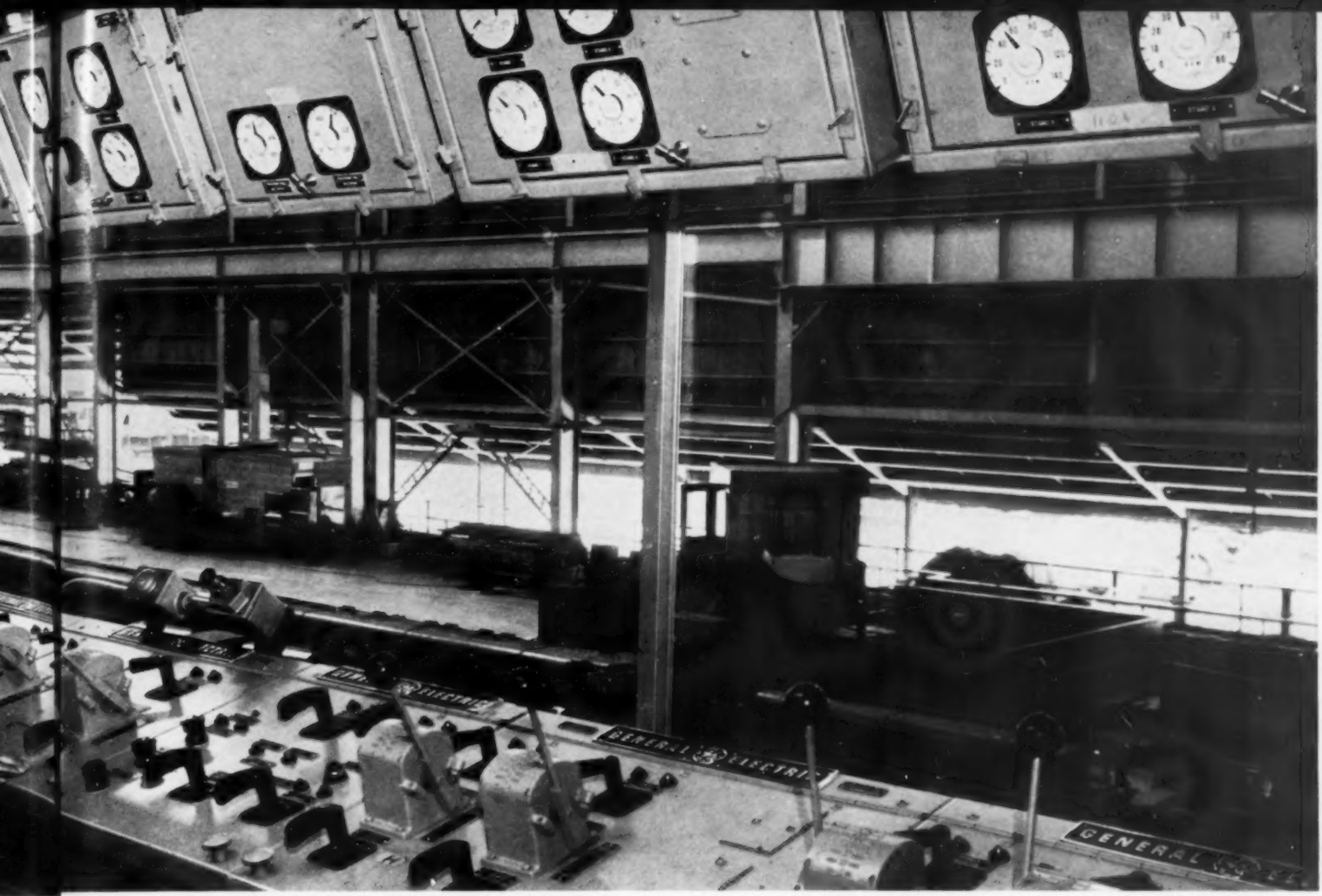
LOAD RATIO CONTROL provides best power factor, eliminates need to shut down mill to change voltage level. Rectifier regulating transformers and power circuit breakers are part of all General Electric outdoor package substation.



EASY REMOVAL of motors is facilitated by individual plug type connectors for each of 123 Tri-Clad* '55' 1-hp, adjustable frequency, a-c motors installed on cooling bed runout table.



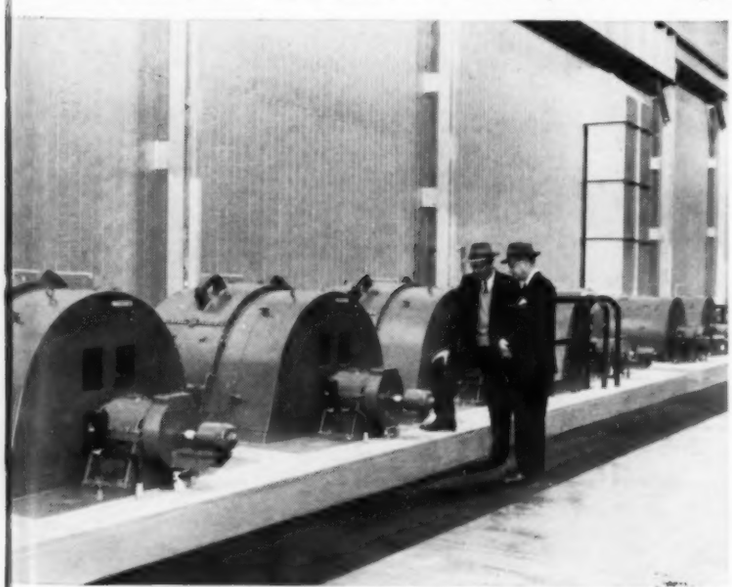
HIGH EFFICIENCY power supply is provided by these 1500-kw and 3500-kw mercury arc rectifier unit substations. Package construction provides lower installation cost, greater safety.



CENTRALIZED OPERATOR'S CONTROL of the mill is carried out from this air conditioned pulpit, located above the mill floor.

New drive system reduces buckling and one of world's fastest combination mills

General Electric's new speed regulators also shorten rescheduling time



ATLANTIC VICE PRESIDENT of Operations J. H. Girdler and General Electric Sales Engineer R. P. Crockett inspect General Electric main-drive motors totalling 8450 horsepower.

The Atlantic Steel Company's new combination merchant bar and rod mill, powered by a General Electric co-ordinated drive system, is the South's newest and most modern rolling mill. Its maximum delivery speed of 5000 fpm for rods and 2000 fpm for merchant products makes it one of the world's fastest combination mills.

THE DRIVE SYSTEM has standard mill motors with new amplistat-amplidyne regulator designed to hold 0.25% steady-state speed error from no-load to full-load. The regulating system makes it possible to set no-load speed essentially equal to rolling speed for fast set-up and rescheduling. In addition, the system provides faster response —to reduce over- and underfeed due to impact speed drop.

THIS MODERN, NEW MILL DRIVE system was the result of close co-operation between Atlantic Steel personnel, The Morgan Construction Co., Rust Engineering Co., and G-E engineers. *G-E engineers are also ready to work with you and your consultants to help meet production requirements. Get complete information from your nearest Apparatus Sales Office.* General Electric Co., Section 659–116, Schenectady, New York. **Registered trade-mark of General Electric Company*

Engineered Electrical Systems for the Steel Industry

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All ingot moulds by Valley are designed for individual steel plant conditions. These moulds have been proven the highest quality available to the steel producing industry today.

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Rust-Oleum is distinctive as your own fingerprint. Accept no substitute.

. . . goes on faster, stops rust, lasts longer over rust!

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ONE MAN often does the work of two!

EASIER TO USE—because Rust-Oleum 769 Damp-Proof Red Primer goes over rusted metal after scraping and wirebrushing to remove rust scale and loose rust—usually eliminating costly surface preparations. *Stops Rust*—because Rust-Oleum's specially-processed fish oil vehicle *penetrates* rust to bare metal—driving out air and moisture that cause rust.

LASTS LONGER applied over rust—and teamed up with Rust-Oleum's many attractive finish coatings, assures lasting beauty. Try Rust-Oleum on *your* tanks, metal sash, machinery, wire fences, stacks, girders—or around *your* home. Prompt delivery from Industrial Distributor stocks. Write for illustrated literature with color charts showing colors and applications.

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30% GREATER COVERAGE—MANY ATTRACTIVE COLORS

Rust-Oleum covers up to 30% more area, depending upon surface condition and porosity. And you can beautify as you protect with Rust-Oleum finish coatings in Aluminum, White, Red, Gray, Green, Blue, Yellow, Black, etc.

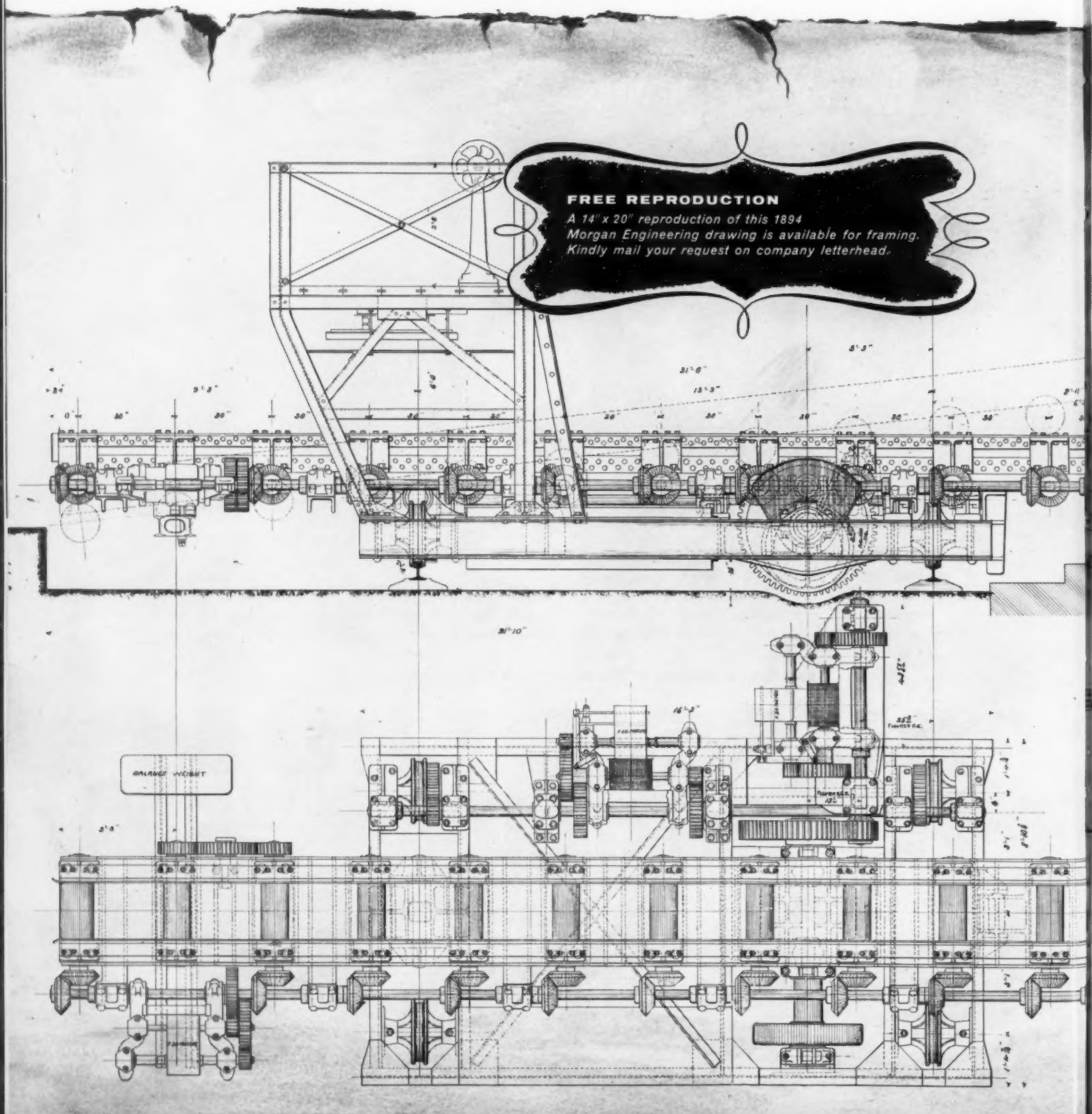
STOPS RUST!®

Rust-Oleum and Stops Rust are brand names and registered trademarks of the Rust-Oleum Corporation.

Write for special report showing Rust-Oleum penetration to bare metal.

WE grow our own SKILLED

...TO ASSURE THE QUALITY OF

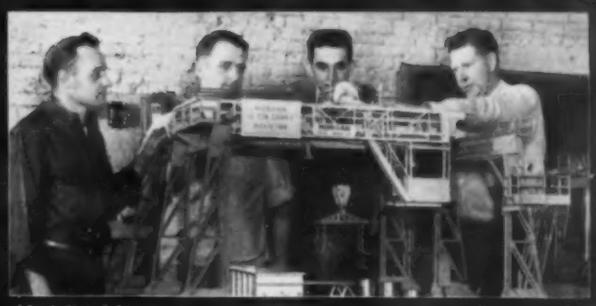


FREE REPRODUCTION

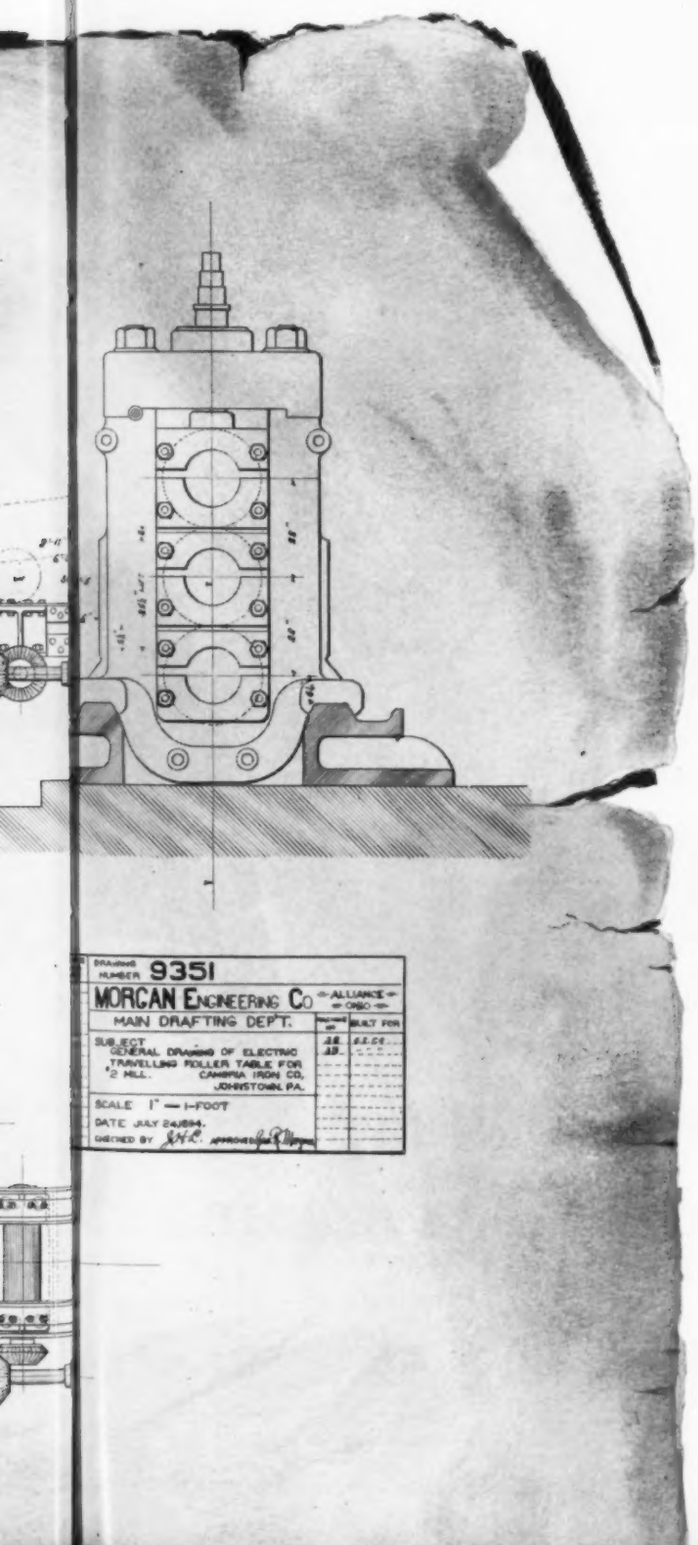
A 14" x 20" reproduction of this 1894 Morgan Engineering drawing is available for framing. Kindly mail your request on company letterhead.

WORKMEN

MORGAN EQUIPMENT



Models of Morgan equipment are set up in the classroom. An apprentice who will work on a giant 500-ton ladle crane learns how his job will influence the crane's overall performance.

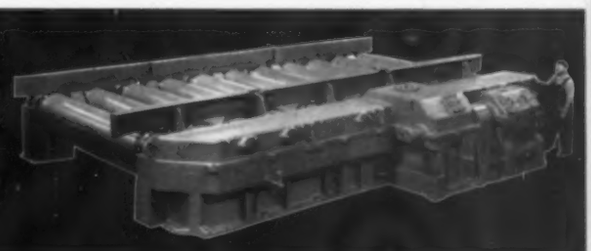


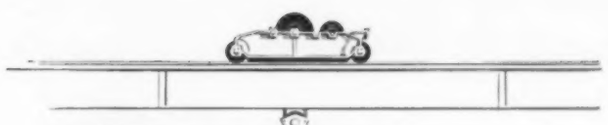
Today, a large percentage of the skilled craftsmen, engineers and supervisors responsible for the construction of Morgan cranes and mill equipment are graduates of our own training program. Morgan Engineering's nationally recognized apprentice program provides 4 years (8400 hours) of carefully planned and supervised shop and classroom training. Applicants far outnumber openings. We are able to select men with the most desirable attitudes and aptitudes for exacting work . . . to develop their skills and a keen sense of responsibility for the overall performance of every Morgan-built product.

Morgan Engineering's apprentice program was started in 1890 . . . to develop *real craftsmen* who would safeguard our reputation for carefully controlled quality in every detail of design and construction. This kind of far-sighted planning is one of the reasons why industry has always been able to rely on Morgan equipment for efficient, dependable, long-lived performance . . . in cranes, mills, roller tables, shears, saws, presses and other Morgan products which are handling the big jobs and the tough ones.

Let our representative show you how to speed production and lower costs with equipment designed and built by Morgan.

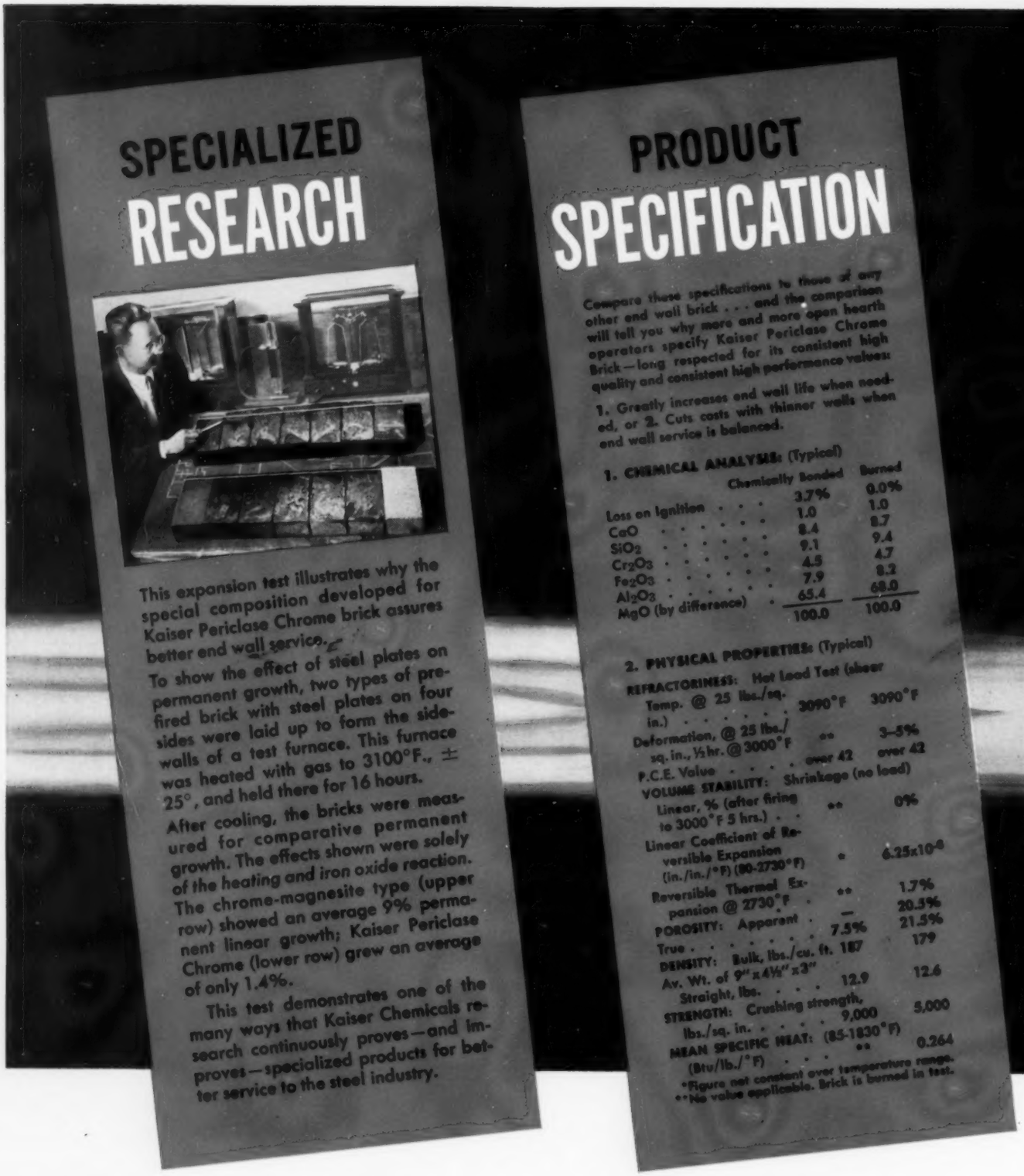
Apprentices see all types of custom-built equipment on Morgan's huge erection floor. Shown, a back mill table for a slabbing and blooming mill.





THE
MORGAN
ENGINEERING CO. *Alliance, Ohio*

Overhead Electric Traveling Cranes
Gantry Cranes • Open Hearth Special Cranes
Plate Mills • Blooming Mills • Structural Mills
Shears • Saws and Auxiliary Equipment


SPECIALIZED
RESEARCH
This expansion test illustrates why the special composition developed for Kaiser Periclase Chrome brick assures better end wall service.
To show the effect of steel plates on permanent growth, two types of pre-fired brick with steel plates on four sides were laid up to form the side-walls of a test furnace. This furnace was heated with gas to 3100°F., ± 25°, and held there for 16 hours.
After cooling, the bricks were measured for comparative permanent growth. The effects shown were solely of the heating and iron oxide reaction. The chrome-magnesite type (upper row) showed an average 9% permanent linear growth; Kaiser Periclase Chrome (lower row) grew an average of only 1.4%.
This test demonstrates one of the many ways that Kaiser Chemicals research continuously proves—and improves—specialized products for better service to the steel industry.
PRODUCT
SPECIFICATION
Compare these specifications to those of any other end wall brick . . . and the comparison will tell you why more and more open hearth operators specify Kaiser Periclase Chrome Brick—long respected for its consistent high quality and consistent high performance values:
1. Greatly increases end wall life when needed, or 2. Cuts costs with thinner walls when end wall service is balanced.
1. CHEMICAL ANALYSIS: (Typical)
Chemically Bonded
Burned
Loss on Ignition 3.7% 0.0%
CaO 1.0 1.0
SiO2 8.4 8.7
Cr2O3 9.1 9.4
Fe2O3 4.5 4.7
Al2O3 7.9 8.2
MgO (by difference) 65.4 68.0
100.0 100.0
2. PHYSICAL PROPERTIES: (Typical)
REFRACTORINESS: Hot Load Test (shear Temp. @ 25 lbs./sq. in.) 3090°F 3090°F
Deformation, @ 25 lbs./sq. in., ½ hr. @ 3000°F ** 3–5%
P.C.E. Value over 42 over 42
VOLUME STABILITY: Shrinkage (no load)
Linear, % (after firing to 3000°F 5 hrs.) ** 0%
Linear Coefficient of Reversible Expansion (in./in./°F) (80-2730°F) * 6.25x10-6
Reversible Thermal Expansion @ 2730°F ** 1.7%
POROSITY: Apparent — 20.5%
True 7.5% 21.5%
DENSITY: Bulk, lbs./cu. ft. 187 179
Av. Wt. of 9" x 4½" x 3" Straight, lbs. 12.9 12.6
STRENGTH: Crushing strength, lbs./sq. in. 9,000 5,000
MEAN SPECIFIC HEAT: (85-1830°F) (Btu/lb./°F) ** 0.264
*Figure not constant over temperature range.
**No value applicable. Brick is burned in test.

All three show why you get superior with Kaiser Periclase Chrome

USERS' EXPERIENCE

COMPARATIVE END WALL TRIAL
"... had inspected walls day prior to accident and noted Kaiser Periclase Chrome Metal Encased Brick sections were plumb, in line and tight whereas other panels were bowed and leaking."

END WALL REPORT
"... Panels of Kaiser Periclase Chrome Metal Encased Brick went 402 heats while comparative panels in the same campaign were replaced at 265 heats."

END WALL REPORT
"... Furnace finished its third campaign using Kaiser Periclase Chrome Brick end wall for a total of 562 heats. Furnaces using other brick usually lasted only 200 heats—one campaign."

These statements from Kaiser Chemicals customers illustrate new performance or production records made possible by changing to Kaiser Periclase Chrome basic brick.

This brick—like every other Kaiser Chemicals refractory—is especially designed for peak performance in a specific application. Its patented composition is backed by more than 15 years of continuous research, development and experience.

Let your Kaiser Chemicals sales engineer explain how you can take full advantage of Kaiser Periclase Chrome Brick in your operation.

end wall service Basic Brick

Call or write Kaiser Chemicals Division, Dept. S7451, Kaiser Aluminum & Chemical Sales, Inc., at any of the regional offices listed below:

PITTSBURGH 22, PA. . . 3 Gateway Center
HAMMOND, IND. . . 518 Calumet Building
OAKLAND 12, CALIF. . . . 1924 Broadway

CHEMICALS KAISER REFRACTORIES

Kaiser Chemicals

Pioneers in Modern Basic Refractories

REFRACTORY BRICK & RAMMING MATERIALS • CASTABLES & MORTARS • MAGNESITE • PERICLASE • DEADBURNED DOLOMITE • ALUMINAS

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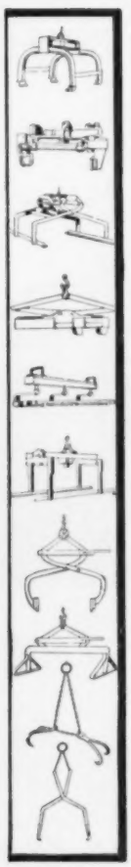
Scientifically Engineered

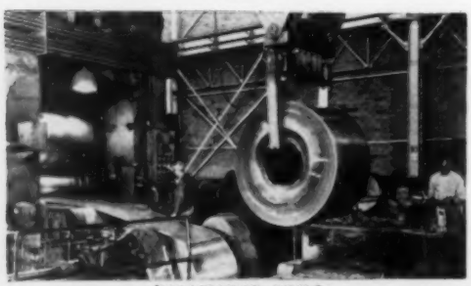
MANSAVER® GRABS

. . . Designed for *Your* Industry

There is no need to spend money having your engineers learn an entirely new *business*. Let them devote their skill to the development of your *own* products. You will find Mansaver a good source of well-designed grabs.

There's a Mansaver Grab for every handling need in manual, semi- and fully-automatic models for lifting steel, brass, copper, aluminum sheet, coils, rod, slab, barrels—anything made by man or supplied by nature!





HANDLING COILS

HANDLING SHEETS

Write for list of satisfied users and name of our nearest representative.

MANSAVER INDUSTRIES, INC.,
3116 EAST ST., NEW HAVEN 11, CONN.
Also Manufactured in England

"No secondary cleaner required with a P-A Washer"

. . . says
FURNACE
SUPERINTENDENT

This economical feature of the Pease-Anthony washer is only one of the many reasons why P-A is first choice with blast furnacemen.

It's a "natural" where high top pressures are used . . . puts full top pressure to work cleaning gas . . . low water consumption . . . low initial cost with minimum maintenance requirements . . . compact design requires little space.

Units available for capacities ranging up to 150,000 SCFM. Write for descriptive bulletin.

Performance summary of some P-A Washers now in use:

Installation	Years Operated	Volume SCFM	Pressure Drop Inches Water	Dust Loading Grains/SCF	
				Inlet	Outlet
A	4	78,000	30	3-19.0	.01-.04
B	3½	78,000	30	2-3	.02-.08
C	3	85,000	30-40	2-3	.01-.03
D	3	45,000	30	2	.02-.03
E	½	75,000	50	—	.02
F*	½	26,000	12	5	.10
G*	½	26,000	12	5	.10
H	½	90,000	29	—	.04

Installation C is in Illinois. Installation H is in Texas.
All others are in Pennsylvania.

*Two units in parallel on one furnace. Lower efficiency due to lower available top pressure.

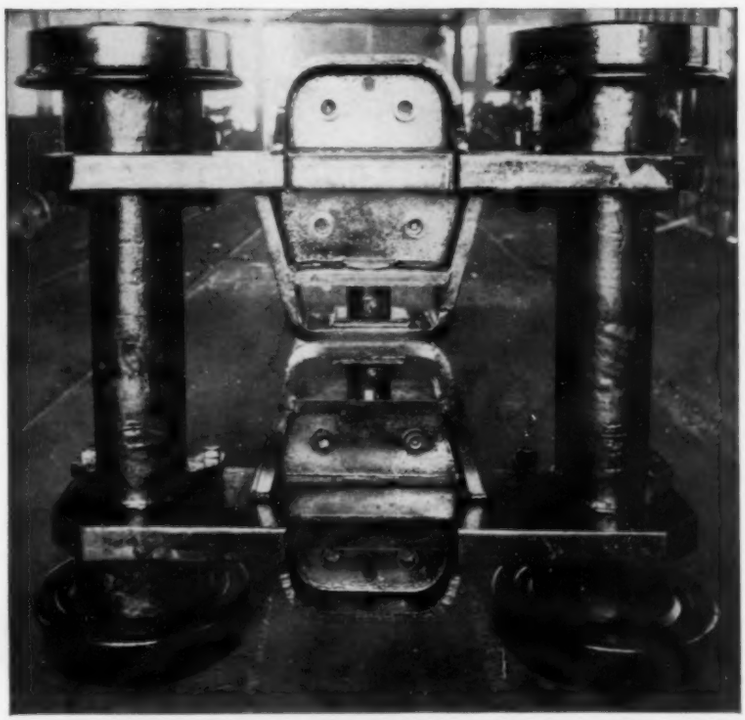
CHEMICO
P-A GAS SCRUBBERS

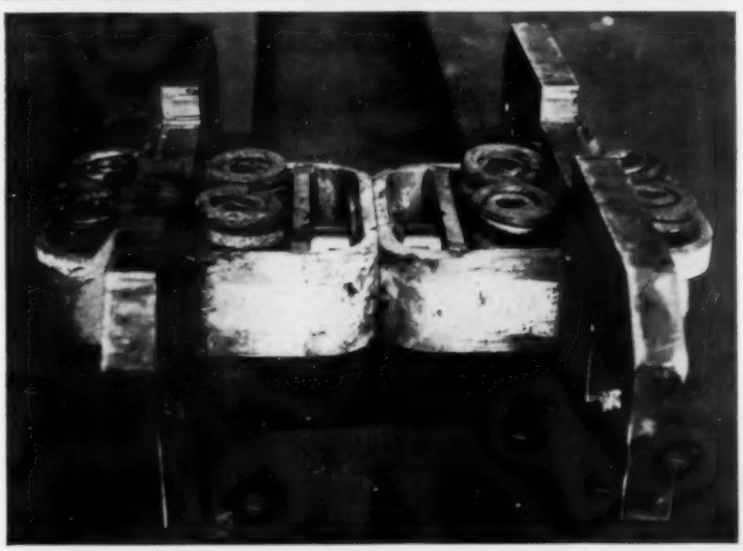
CHEMICAL CONSTRUCTION CORPORATION

A Subsidiary of Electric Bond and Share Company

525 West 43rd Street, New York 36, New York
Telephone LOngacre 4-9400

Technical Representatives Throughout The World
Cable Address: CHEMICONST, N. Y.





Top: Truck assembly. Center: Side frame and spring nest assembly. Bottom: Ingot Mold Car, compensating truck type Bauer patents.

TEN REASONS WHY MORE THAN 1000 TREADWELL INGOT MOLD CARS ARE NOW IN SERVICE

Consider these items feature by feature. The body is a single unit. Center of gravity is especially low. The trucks may be removed quite easily. Body is overhung. Stool rests to meet requirements. Provision is made for ample stripper allowance. Automatic or link and pin couplers. Floor protection plates are replaceable. Wheels move independent of side frames. Independent vertical movement of truck frames.

TREADWELL
CONSTRUCTION COMPANY
PLANT AND MAIN OFFICE BOX 20 MIDLAND, PA.
NEW YORK ..... PITTSBURGH ..... CHICAGO

Plant adds $440,000 operating credit when Dowell cleans "problem" superheater – chemically!

Here's how a modern plant overcame a serious and potentially costly maintenance problem.

Scale deposits were causing tube failures in the superheater of a 175,000 pound-per-hour boiler. To clean the tubes mechanically and replace them would require 14 days of *unscheduled outage* time. In dollars and cents this meant $40,000 per day of lost throughput for the company.

To complicate the problem further, the superheater was a non-drainable type.

Dowell engineers, using their wide experience in the chemical cleaning of various types of equipment, developed a special cleaning technique for this type of superheater. Dowell provided all the pumping and control equipment, trained personnel and chemicals to do the job, and *restored the unit to top operating efficiency in 3½ days.*

Whether your cleaning problem involves simple units—or complex pieces of special equipment, Dowell has the facilities and experience to solve it. Versatile Dowell Service has proved itself in many industries—for example: chemical, construction, paper, petroleum, steel.

Find out today how Dowell chemical cleaning can help your plant to greater profits. Call the Dowell office nearest you. Or write Dowell Incorporated, Tulsa 1, Oklahoma.

have Dowell clean it chemically DOWELL

A SERVICE SUBSIDIARY OF THE DOW CHEMICAL COMPANY

Date-line Diary...

August 1

▲ The Agricultural Dept. reported farm exports for the fiscal year ended June 30, 1957 amounted to $4,700,000,000, or 35 per cent higher than 1956.

▲ Westinghouse Electric Corp. reported for the first half of 1957, sales totaling $982,939,000, net profit $30,615,000 or $1.77 per share; this compares with sales of $606,097,000, loss of $11,713,000 or $0.76 a share, one year ago. Sales for the second quarter in 1957 were $507,253,000, net income $16,417,000 or $0.95 a share, compared with sales of $380,731,000, net profit of $6,862,000 or $0.38 a share for the same period 1956.

August 3

▲ The Aluminum Assn. reports net shipments of aluminum sheet and plate for June, 1957 totaled 105,927,000 lb, compared with 119,603,000 lb in May, 1957; shipments of foil in June, 1957 were 12,707,834 lb, in May, 1957, 13,845,888 lb.

▲ According to the Bureau of Mines, U. S. Dept. of the Interior, U. S. iron mines produced 6,676,532 gross tons and shipped 5,580,729 tons of iron ore during April, 1957. Mine stocks at the end of April totaled 12,390,002 gross tons. Imports of iron ore in April amounted to 1,800,720 gross tons; exports of iron ore totaled 152,055 gross tons.

August 5

▲ The Government's Export-Import Bank granted the Fuji Iron & Steel Co., Ltd., credit of $10,300,000 to finance purchase of heavy rolling machines here to cover a part of an $89,000,000 expansion program at its Hirohata Works.

▲ Operations at Great Lakes Steel Plant have been completely shut down by a strike of workers on the second shift to protest disciplinary action by the company against 117 employes.

▲ The AISI reports that the operating rate of the steel industry for the week of August 5 is scheduled at 81.7 per cent of capacity. This is equivalent to 2,092,000 tons compared with 2,033,000 tons one week ago and 1,415,000 tons one year ago. Index of production for the week is 130.2.

August 6

▲ The FHA lowered minimum down payments on mortgages insured by the agency to 3 per cent on the first $10,000, 15 per cent on the next $6000, and 30 per cent on amounts over $16,000. Previous requirements had been 5 per cent on the first $9000 and 25 per cent on higher amounts.

▲ The Commerce Dept. reported exports for the first half of 1957 of $10,200,000,000 or 22 per cent over the same period in 1956. Imports for the first six months of 1957 amounted to $6,400,000,000, or $100,000,000 higher than in 1956.

▲ The ICC granted freight rate increases of 7 per cent for eastern and western railroads, and 4 per cent to southern roads.

▲ Price of copper was lowered ¾¢ to 28½¢ per lb.

▲ Shipments of iron and steel castings during May, 1957 amounted to 1,353,175 short tons compared with 1,363,118 short tons in April, 1957 and 1,493,996 short tons in May, 1956.

August 9

▲ Pittsburgh Coke & Chemical Co. reported sales for the second quarter of 1957 amounting to $13,347,000, income of $744,000 equal to $0.55 per share, compared with sales of $19,512,000, income of $1,133,000 or $0.90 per share for the same period of 1956. First half 1957 sales totaled $27,028,000, income $1,652,000, or $1.25 per share, compared with sales totaling $34,120,000, income $1,967,000 or $1.54 per share for the first half of 1956.

▲ According to the AISI the iron and steel industry's estimated payroll for the first half of 1957 totaled $2,029,780,000, compared with $1,966,650,000 during the first half of 1956; the average hourly payroll cost during the first half of 1957 equaled $2.843 for each hour worked which does not include an average cost of 29¢ per hr for pensions, social security, etc. Average hours worked were 38.6 compared to 39.9 hrs in 1956; estimated employment was 671,500 during the first half of 1957. Estimated payroll for June, 1957 amounted to $324,823,000, estimated total employment 666,400, average hourly payroll cost per wage earner $2.862, and average hours worked a week 36.7.

▲ The Agriculture Dept. forecast a cotton crop for 1957 of 11,897,000 bales, compared with a crop for 1956 of 13,310,000 bales and the 1945-average of 13,669,000 bales. Farm Chief Benson raised cotton price supports to 78 per cent of parity, up one per cent.

August 12

▲ The AISI reports that the operating rate of the steel industry for the week of August 12 is scheduled at 81.9 per cent of capacity. This is equivalent to 2,097,000 tons compared with 2,043,000 tons one week ago and 2,154,000 tons one year ago. Index of production for the week is 130.5.

▲ Keystone Steel & Wire Co.'s preliminary report for the year ended June 30 shows sales at $112,488,242, net profit $8,476,095 or $4.52 per share compared with 1956 sales at $118,294,006, net profit at $10,080,301 or $5.38 per share.

August 13

▲ The Commerce and Labor Depts. reported that employment in mid-July totaled 67,200,000, close to 1,000,000 over the 1956 total, and a gain of 700,000 over June, 1957. However, the number of factory workers declined more than 180,000 from mid-June leaving 16,700,000 employed in July.

August 14

▲ Canadian output of steel ingots in July, 1957 amounted to 417,974 tons, compared with 432,440 tons in July, 1956; production in the first seven months of 1957 totaled 3,033,945 tons compared with 2,988,886 tons in the same period of 1956. Pig iron output in July amounted to 329,814 tons compared with 307,642 tons in July, 1956; for the first seven months of 1957 the output amounted to 2,252,233 tons compared with 2,035,326 tons in 1956.

▲ Acting Attorney General Rogers reported that nickel supplies available for domestic use have been lifted by government programs to 290,000,000 lb a year from 200,000,000 lb in 1950, and by 1961, he estimated, supplies are expected to total 450,000,000 lb.

August 16

▲ The Commerce Dept. reported that national production of goods and services for the second quarter rose to a yearly rate of $434,400,000,000, exceeding the first quarter pace by $5,200,000,000.

▲ Personal income, the Commerce Dept. reported, for July, 1957 rose to an annual rate of $345,500,000,000.

▲ The value of the Canadian dollar rose to $1.057 in U. S. currency, the highest price in history.

August 19

▲ State authorities of Texas authorized a step up in crude oil production, setting September output allowable at 3,127,506 barrels a day, 68,287 barrels above the current limit.

▲ The Bureau of Mines reported that U. S. iron ores produced 12,586,928 long tons and shipped 13,393,025 tons in May, 1957 compared with 6,676,532 tons produced and 5,580,729 tons shipped in April, 1957. Imports in May totaled 3,186,847 tons, up 77 per cent over April imports; exports in May amounted to 661,444 long tons.

▲ The AISI reports that the operating rate of the steel industry for the week of August 19 is scheduled at 82.9 per cent of capacity. This is equivalent to 2,123,000 tons compared with 2,062,000 tons one week ago and 2,359,000 tons one year ago. Index of production for the week is 132.2.

▲ The ARCI reports that deliveries of new domestic freight cars in July, 1957 totaled 7725 compared with 8377 in June, 1957 and 5344 in July, 1956. Orders totaled 1251 compared with 4918 in June, 1957 and 2642 in July, 1956. Backlog of cars on order as of August 1, 1957 stood at 85,229 cars.

August 20

▲ The Aluminum Assn. reported primary aluminum production in the United States during July, 1957 was 142,157 short tons compared with 138,007 tons in June, 1957 and 151,624 tons in July, 1956.

▲ Stocks suffered the worst break in nearly two years, and the Dow-Jones industrial average dropped 9.25 points.

▲ Otis Brubaker, research director for the United Steelworkers of America, testified before the Senate Judiciary subcommittee that the steel industry could have cut prices in 1957 and still made greater net profits. He further stated that steelworkers are producing 71.2 per cent more steel per manhour now than in 1939 while wage increases have gone up 52.7 per cent.

August 21

▲ Resistance Welder Manufacturers' Assn. reported that shipments by members in July, 1957 amounted to more than $3,000,000, 17 per cent over June, 1957 shipments, with backlog at July 31 at $9,500,000.

August 22

▲ McLouth Steel Corp. concluded agreements on $64,000,000 of 5½ per cent first mortgage bonds, due 1976.

August 23

▲ Freeport Sulphur Co. completed arrangements for its subsidiary, Cuban American Nickel Co., to borrow $100,250,000 from banks and large nickel consumers to pay for new nickel producing facilities in Cuba and for a large refinery at Braithwite, La. The Louisiana plant, scheduled to begin operation in mid-1959, will produce about 50,000,000 lb of nickel and 4,400,000 lb of cobalt annually.

▲ Consumer prices in July climbed to 120.8 per cent of the 1947–49 average, an increase of 0.5 per cent over June, 1957 and 3.2 per cent over July, 1956.

▲ General Motors rejected the proposal by Walter Reuther, head of United Auto Workers, to reduce the prices of its 1958 models by $100 from current levels, countering with the proposal that the U.A.W. announce willingness to extend its present GM contract intact for two years beyond its expiration date, May 29, 1958.

▲ Copper prices further declined ½¢ to 27¼¢ a lb. Union Miniere trimmed its price by 0.90¢, quoting at 26.80¢ a lb in Antwerp, Belgium and New York.

▲ Government figures showed that building activities in July lagged, decreasing to $4,400,000,000.

▲ The Bureau of Mines reports that the consumption of scrap during June, 1957 totaled 5,436,000 gross tons and pig iron 5,653,000 gross tons compared with 5,753,435 tons of scrap and 5,862,966 tons of pig iron in May.

▲ The AISC reports that shipments of fabricated structural steel for July, 1957 were 303,512 tons compared with 329,256 tons in June, 1957 and 165,470 tons in July, 1956. Bookings for July, 1957 were 202,772 tons compared with 220,025 tons in June, 1957 and 288,166 tons in July, 1956. Backlog on July 31 equaled 3,137,526 tons, approximately 9 per cent above a year ago.

August 26

▲ The AISI reports that the operating rate of the steel industry for the week of August 26 is scheduled at 83.3 per cent of capacity. This is equivalent to 2,132,000 tons compared with 2,101,000 tons one week ago and 2,389,000 tons one year ago. Index of production for the week is 132.7.

August 27

▲ Machine tool orders rose sharply in July amounting to $55,800,000, approximately three per cent over June, 1957 bookings, but below the $61,900,000 volume of July, 1956.

▲ Copperweld Steel Co. and Superior Steel Corp. have agreed to "principle" of merger, at ¾ share of Copperweld in exchange for one share of Superior. Formal merger agreements will be submitted to the boards of both companies for approval in the near future, then submitted at special meetings of the stockholders of both companies.

▲ The SEC opposed as "unfair" the proposed reorganization plan for Northeastern Steel Corp., advanced by the Carpenter Steel Co., who propose they take control of Northeastern by exchange of stock. The SEC opposing report contends that the stock Carpenter intends to offer does not represent fair compensation for the interest in the assets and facilities being acquired.

August 29

▲ Copper prices were dropped another ¼¢ to 27¢ a lb by custom smelters. In London spot copper firmed up slightly to 25.34¢ a lb, after having reached a low of 25.18¢ per lb.

August 30

▲ According to the Dodge report contracts for future construction in the United States in July totaled $2,900,681,000, four per cent under July, 1956. Contracts for residential buildings in July were valued at $1,286,937,000, 13 per cent over the July, 1956 level.

▲ The Bureau of Mines reported that the total consumption of scrap in 1956 equalled 80,315,170 short tons compared with 81,375,099 tons consumed in 1955; consumption of pig iron in 1956 totaled 74,995,479 short tons compared with 77,216,335 short tons in 1955.

CURRENT AISE DISTRICT SECTION MEETING NOTICES

BIRMINGHAM SECTION

Saturday, October 26, 1957—Inspection Trip 9:30 A.M., Dinner 6:30 P.M., Meeting 8:00 P.M.

Inspection Trip—Atlantic Steel Company

"A Modern Rod and Merchant Mill," by W. R. Potts, Chief Engineer, and R. M. Lang, Superintendent Rod and Bar Mills, Atlantic Steel Company, Atlanta, Ga.

Dinner and Meeting, Dixie Ball Room, Henry Grady Hotel, Atlanta, Ga.

BUFFALO SECTION

Tuesday, October 8, 1957—Social Hour 6:30 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Engineering Problems and Construction Progress of the St. Lawrence Power Project," by Richard E. Burnett, Assistant Project Manager, Uhl, Hall, and Rich, Niagara Falls, N. Y.

Dinner and Meeting, Sheraton Hotel, Buffalo, N. Y.

CHICAGO SECTION

No October Meeting.

CLEVELAND SECTION

Tuesday, October 22, 1957—Social Hour 6:00 P.M.. Dinner 6:30 P.M., Meeting 8:00 P.M.

"Guiding Steel Mill Engineers Toward Management Responsibility." Speaker to be announced later.

Dinner and Meeting, University Club, Cleveland, Ohio

DETROIT SECTION

Thursday, October 10, 1957—Social Hour 6:30 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

GOLDEN (50th) ANNIVERSARY MEETING. Speaker to be announced later. During the day there will be an inspection Trip to Ford Motor Steel Division and Great Lakes Steel, Division of National Steel Corp., for senior engineering students from University of Michigan, Michigan State, and University of Detroit. This is part of the educational program sponsored by the AISE.

Dinner and Meeting, Sheraton-Cadillac Hotel, Detroit, Mich.

LOS ANGELES SECTION

Monday, October 14, 1957

"Appraisal of Rectifiers in the Steel Industry," by L. C. Holman, Application Engineer, General Electric Co., Los Angeles, Calif., and R. J. Moran, Application Engineer, Systems Application Engineering Section, General Electric Co., Schenectady, N. Y.

Dinner and Meeting, Michaels Restaurant, Washington and Telegraph Road, Los Angeles, Calif.

PHILADELPHIA SECTION

No October Meeting.

PITTSBURGH SECTION

No October Meeting.

ST. LOUIS SECTION

Wednesday, October 30, 1957—Dinner 7:00 P.M., Meeting 8:00 P.M.

Speaker to be announced later.

Dinner and Meeting, Elks Club, Granite City, Ill.

SAN FRANCISCO SECTION

Tuesday, September 17, 1957

SPECIAL GOLDEN (50th) ANNIVERSARY MEETING.
"Man, Steel and a Bridge," 16 mm. sound film on erection of Richmond San Rafael Bridge. Comment by W. T. Egan, Judson Steel Corp. Emeryville, Calif.

Shattuck Hotel, Berkeley, Calif.

Friday, October 18, 1957—Dinner 7:30 P.M.

Celebration of Golden Anniversary—Golf Tournament.
Tee off 1:00 P.M.—Special Events.

Orinda Country Club

UTAH SECTION

Monday, October 14, 1957—Social Hour 6:30 P.M., Dinner 7:30 P.M., Meeting 8:30 P.M.

"Centrifugal Casting of Pipe in Modern Foundry," by E. Lewis Allen, Chief Engineer Pacific States Cast Iron Pipe Company, Provo, Utah.

Dinner and Meeting, Skyliner Cafe, Provo, Utah

YOUNGSTOWN SECTION

Monday, October 28, 1957

Details not available.

STEEL MEN!

WHY PAY MORE THAN $12 PER TON FOR FLUX BLOCKS?

ORIGINALLY, glass tanks were built of small, fire-clay brick or sandstone blocks. No. 1 fire-brick of this type can be bought for $12 per ton. Clay flux blocks of essentially the same materials cost $60 per ton. Why pay a 500% premium simply to get *bigger pieces* of the same material?

Your reply, of course, is that the larger pieces improve furnace life by 40% to 50%—that you are willing to pay 500% more for your blocks, to get 50% greater life for your tanks. And that is true of every glass-tank owner in America today. Since you are already paying a 500% premium for a 50% return, *why is it not logical for you to buy Corhart Electrocast, at a smaller price premium over clay,* AND GET OVER 200% INCREASE IN FURNACE LIFE?

If you are looking for economy in the purchase of your tank blocks, you need pay only $12 per ton. On the other hand, if you want the lowest cost per day of tank life, or the lowest cost per ton of glass produced, you can not stop at the $12 block *or at the* $60 *block.*

Corhart Electrocast is the world's highest-priced refractory per ton of blocks, and the lowest-cost refractory per ton of glass produced . . . May we *prove* it to you? Write for definite facts. *Address:* Corhart Refractories Co., *Incorporated,* 16th and Lee Sts., Louisville, Ky.

CORHART ELECTROCAST REFRACTORIES

IN June, 1933, when this old ad appeared, Corhart Electrocast was still new in the glass industry. Only a few glass companies dared then to buy it, "one of the world's highest-priced refractories". But today its use is practically universal . . .

Now Corhart 104 is still new in the steel industry — but despite its high price, it offers steel furnace operators the same opportunities for greater production and lower costs that Corhart Electrocast brought to glass.

May we send you complete data? Address: Corhart Refractories Co., Incorporated, 1614 West Lee Street, Louisville, Kentucky, U.S.A., SPring 8-4471.

QUALITY ECONOMY ENDURANCE

CORHART 104 ELECTROCAST REFRACTORY

The words "Corhart" and "Electrocast" are registered Trade Marks which indicate manufacture by Corhart Refractories Company, *Incorporated.* Corhart Refractories Co., *Incorporated,* 1600 West Lee Street, Louisville 10, Kentucky, U.S.A.—Telephone SPring 8-4471.

This Adams CYCLONE Saves You MONEY!

The Aftercooler and Separator that assures

DRIER Compressed Air

Here's real teamwork! First, the Adams Aftercooler brings the compressed air temperature down — within 10 of the cooling water — where it holds almost 40% less moisture than air from conventional units.

Then, the Adams Separator creates a cyclone to efficiently remove the condensate . . . giving you cooler, drier air for your system.

Thousands in use throughout industry. It will pay you to find out all the details. Mail the coupon below today.

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R. P. ADAMS CO., INC. S-57
223 East Park Drive
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Please send my FREE copy of Bulletin #711 on Adams Cyclone Separators and Aftercoolers.

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Designed by Experience

HEAVY-DUTY CAM-OPERATED

600 Volts A-C or D-C

● The Euclid Electric & Mfg. Co. (Madison, Ohio) has added a complete new line of Pendant Push-Button Stations to incorporate all of the many features that years of experience have proved desirable. Designed for heavy-duty applications, these cam-operated Stations are rated 600 volts, a-c or d-c. They are available from one to five speed-points in each direction for a total of eight circuits to provide for practically an unlimited number of different sequences of operation.

Sturdily constructed to withstand hard usage and abuse, their small cross-section permits comfortable, non-fatiguing, one-hand operation. Steel shrouds guard the large operating buttons. The heavy, all-welded steel frame (that includes the end-caps and front) has a heavy, fiber-glass, easily-removed rear cover that affords quick inspection of the silver-to-silver contacts without disturbing any wiring. The threaded conduit fitting is an integral part of the top end-cap which also has welded to it a double-suspension cable hanger.

Extra features include heavy-duty, control-circuit toggle disconnects, pilot lights, selector switches, and maintained-type contacts.

ASK FOR BULLETIN 2015

THE EUCLID ELECTRIC & MFG. CO.
MADISON, OHIO

THE EUCLID ELECTRIC
EUCLID
AND MFG. CO., MADISON, O.

8 good reasons why you should use these ROLLER GUIDES in your bar or wire rod mill

Nos. 125 and 155 roller guides fitted in a 27 1/2 in. (700 mm.) diameter, three-high stand for rolling 2 3/4, 3 3/16, 3 9/16, 4, 4 3/8 and 4 7/8 in. (70, 80, 90, 100, 110 and 124 mm.).

1 The entry friction guides are rigidly clamped into the guide box. They are intended to lead the oval to the groove in the roller, to protect the rollers against overloading, and to straighten bent rods.
The groove in the entry guides is made about 1/8" wider than the oval.

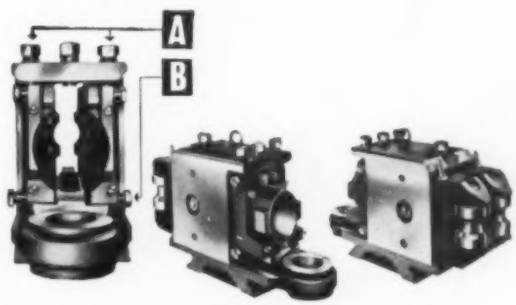
2 The rollers are mounted on leaf springs, which can be adjusted by means of the screws "B", and hold the oval steadily even if there should be some slight variation in the thickness of the oval.

3 If the thickness of the oval should vary, the springs of both rollers yield an equal amount, so that the oval remains in the centre of the groove.

4 To tilt the oval, the screws "A" are adjusted. One roller will then be lifted as much as the other is lowered.

5 As the oval is held very rigidly, the leader oval for wire rod may be thick, unless other circumstances call for a thinner oval.

6 The roller guide assemblies are narrow, and all screws that require adjustment during rolling are accessible from the front of the mill. No lateral space outside the guide box is therefore required for gaining access to the set screws, and the guide box assembly can thus be located close to the mill housing.



7 As the groove in the entry guides is wide and nothing but rolling friction acts on the oval, the latter is very easily introduced into the pass, and there is practically no risk of scratching the bar.

8 The roller guide may be used not only for leader and drawing oval passes but also for edging flats as well as for rolling squares, hexagons, octagons and various other sections, for instance in reduction passes for hexagon. It is suitable for all types of rolling mill. An important advantage is that the roller guide enables repeaters to be used in rolling plump leader-ovals.

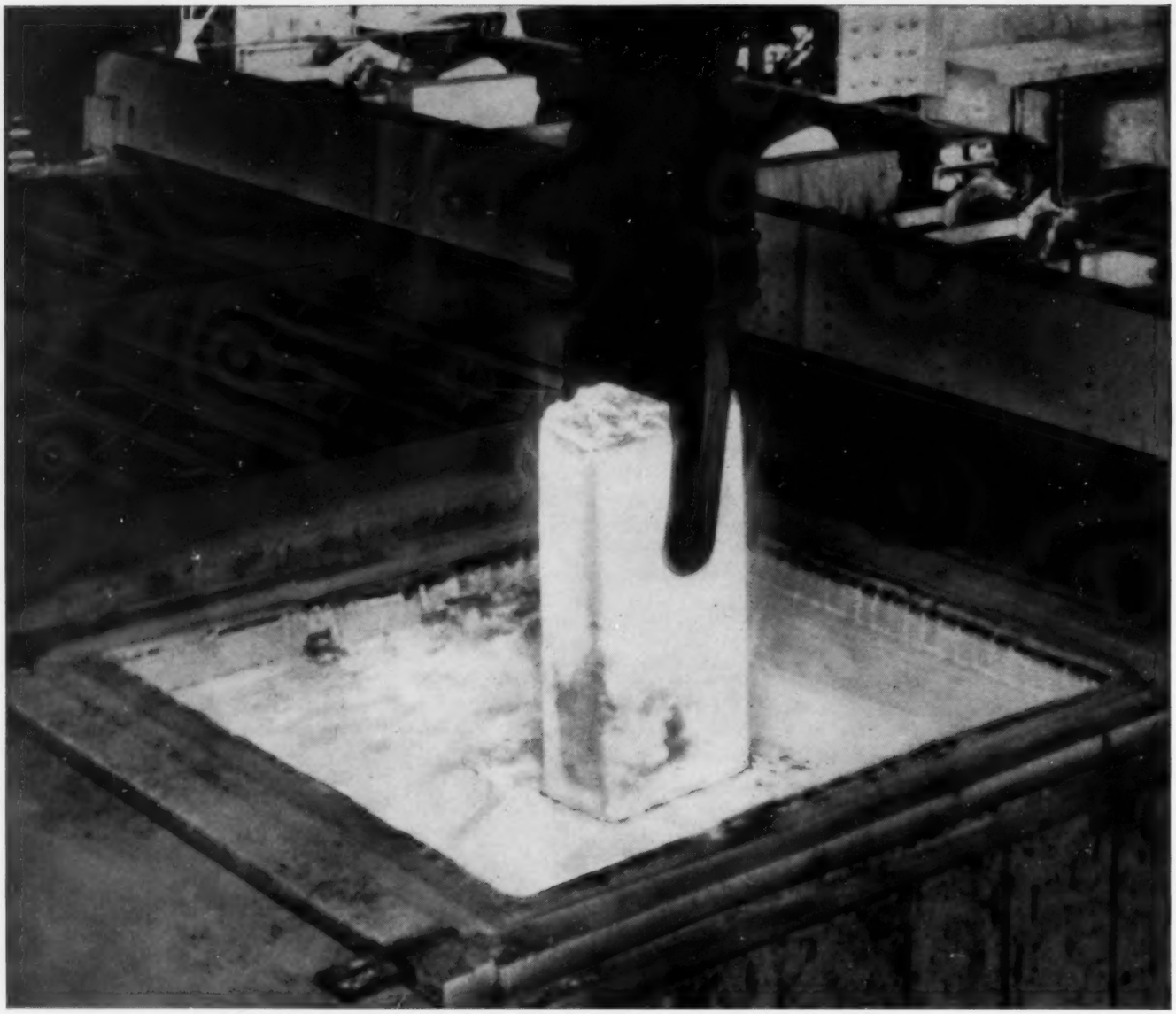
PS *Practically speaking, every bar and wire rod mill in Scandinavia uses roller guides of our design.*

MH **MORGÅRDSHAMMAR**

MORGÅRDSHAMMARS MEK VERKSTADS AB • MORGÅRDSHAMMAR • SWEDEN

SOLE AGENT FOR THE US:
K.W. Atwater Engineering, Inc.
401-03 Butler Street
Pittsburgh 23, P.A.

Telegrams: Morgårdshammar, Ludvika. Sweden



Hagan soaking pit controls

FAST AND EASY INSTALLATION

Hagan systems on the 15 soaking pits installed as a part of Pittsburgh Steel's modernization program include combustion and pit pressure controls. These pits normally burn a mixture of coke oven and blast furnace gas, held to 200 Btu's. This comparatively low Btu content promotes good pit circulation and even heating during the soaking phase.

Oil is available as an alternate fuel, and the Hagan system is so arranged that when oil is fired, the oil flow transmitter impresses a low differential pneumatic signal (same range as gas flow differential) on the fuel/air ratio control and on the fuel/air meter.

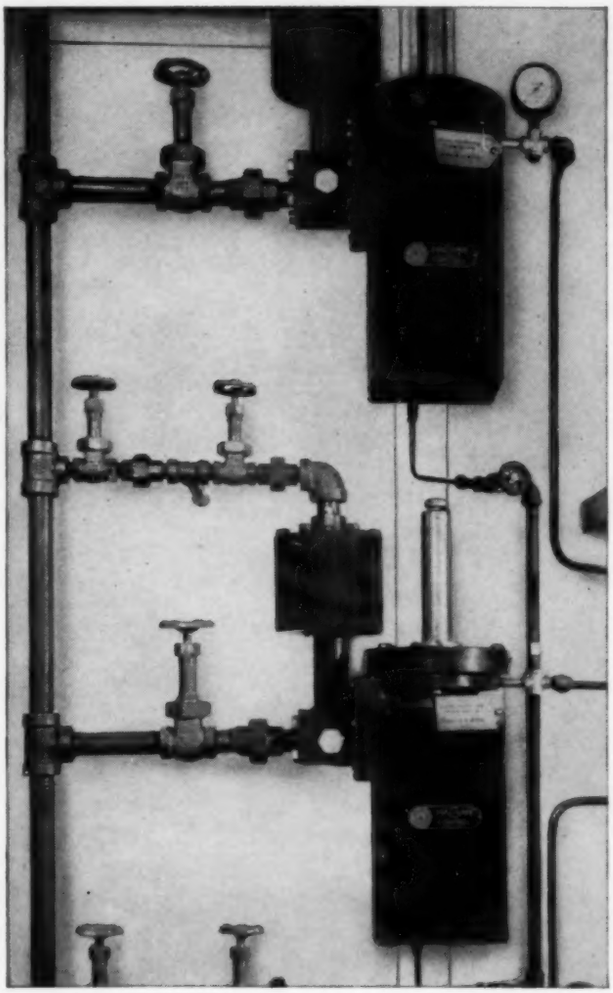
The gas mixing station employs Hagan pressure and ratio controllers to maintain mixed gas header pressure by admitting the two gases in correct proportion.

These systems were put into operation quickly and easily, and plant personnel have found that they stay in calibration and require minimum maintenance.

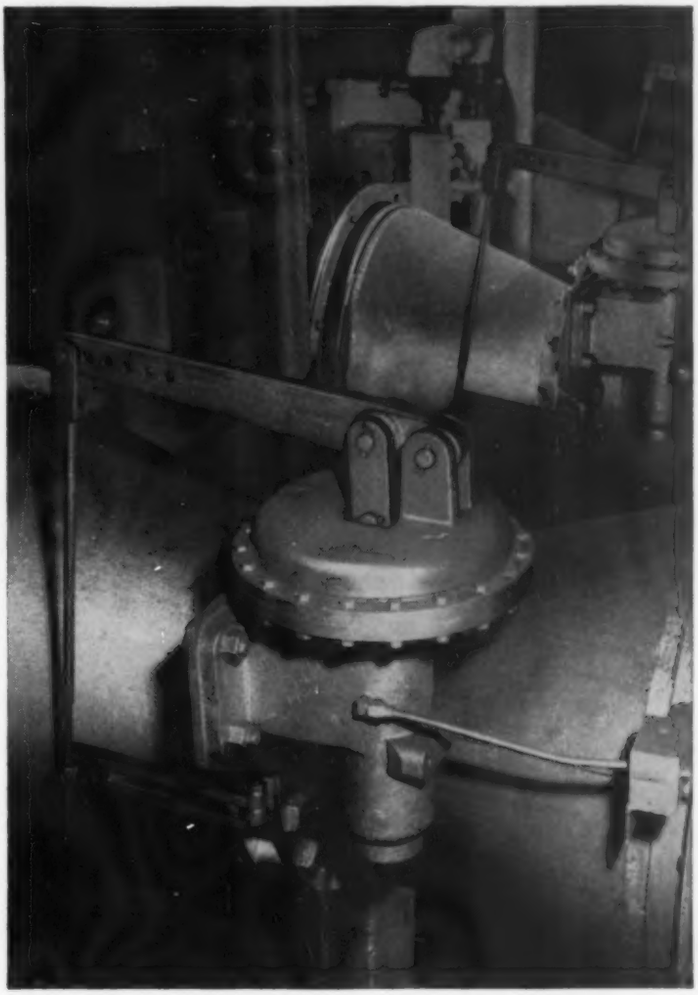
Hagan control systems are also being installed on the enlarged open hearths at Pittsburgh Steel. Fuel/air ratio, furnace pressure control and automatic reversal are among the Hagan automatic control systems to be used on these furnaces.

Hagan systems for soaking pits, blast furnaces, open hearth and heat treating furnaces have established a reputation for accuracy, dependability and minimum maintenance. A Hagan engineer will be glad to discuss metallurgical furnace controls in relation to your particular requirements. A letter or phone call to the address below will receive prompt attention.

Hagan Low-Head Transmitters measure oil flow by means of a sharp edge orifice plate. They develop a low head pneumatic signal which is linear with the differential produced by the oil flow. This signal is then transmitted to the fuel/air ratio control. The Hagan Low-Head transmitter is fast and maintains a high degree of accuracy.

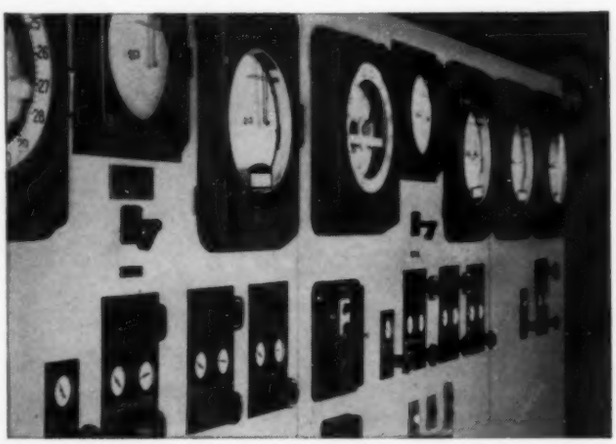


Hagan Diaphragm Operators position low friction dampers on the combustion air inlet fans. These operators provide full modulation, and are extremely fast and accurate. Repeatability is excellent, assuring accurate following of signals from fuel/air ratio control. The Hagan Diaphragm Operator is suited for any low friction positioning application where accuracy and speed are needed.



at Pittsburgh Steel

...MINIMUM MAINTENANCE



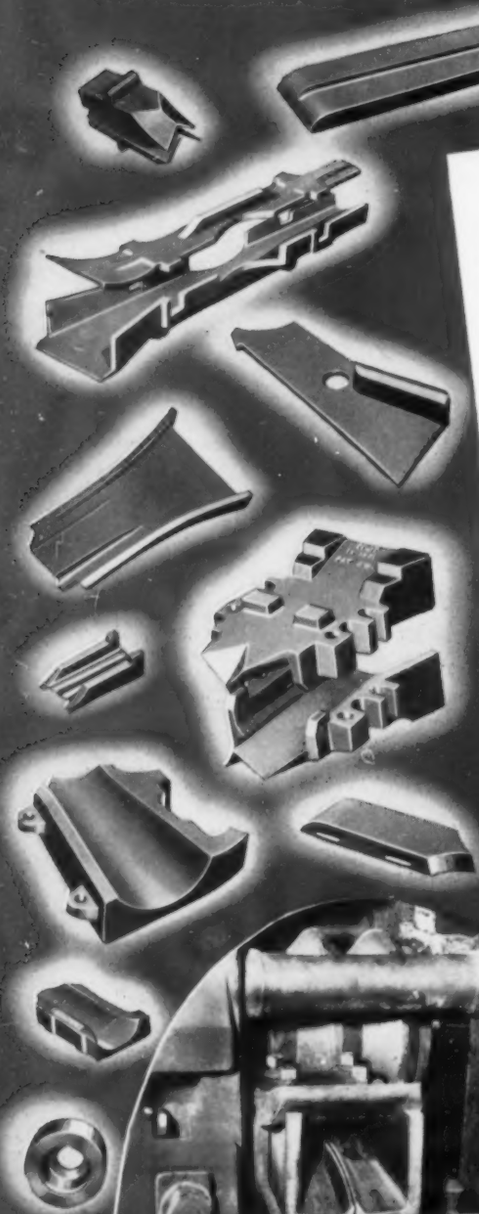
Control Panel shows Hagan Ring Balance meters and Hagan Panel Relays. The Ring Balance meters record fuel/air ratio and pit pressure. Hagan Ring Balance meters are versatile, accurate and dependable instruments. They are calibrated by the dead weight system without disconnecting the meter from the line.

HAGAN CHEMICALS & CONTROLS, INC.

HAGAN BUILDING, PITTSBURGH 30, PENNSYLVANIA

DIVISIONS: CALGON COMPANY • HALL LABORATORIES

TRANTINYL GUIDES
THE STEEL INDUSTRY



Steel Producers amazed at HIGH TONNAGE rolled with TRANTINYL GUIDES

Entry Guides

Delivery Guides

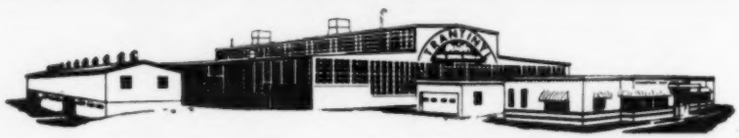
Two pair of angle guides, still in serviceable condition after long usage

These entry and delivery guides on 12" mill were photographed in a midwest steel plant after rolling unusually high tonnage. Guides showed no noticeable signs of wear and proved again the outstanding durability of "TRANTINYL." If you have not yet tested "Trantinyl" guides to your own satisfaction, why not try them now.

12" Mill showing Entry Guides

"Trantinyl" Guides and Rollers hold exceptionally high tonnage performance records, in serving leading steel mills for a quarter-century. Rolling more than 100,000 tons over a single pair of guides has been recorded.

Guides for Rolling Mills • Tube Mills
Straightening Machine Guides
Heat-Resisting "Trantinyl" Cast-to-Shape

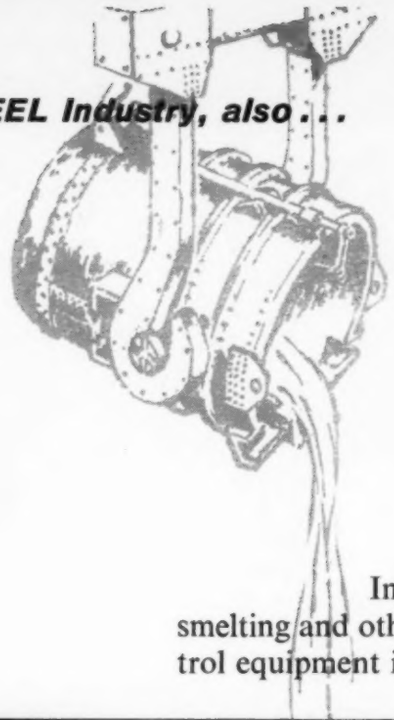


Youngstown Alloy Casting Corporation

Youngstown, Ohio

Sales licensees to cast "TRANTINYL" for the Midwest, West and South — WAUNAKEE ALLOY CASTING CORP., Waunakee, Wis.

In the STEEL Industry, also . . .

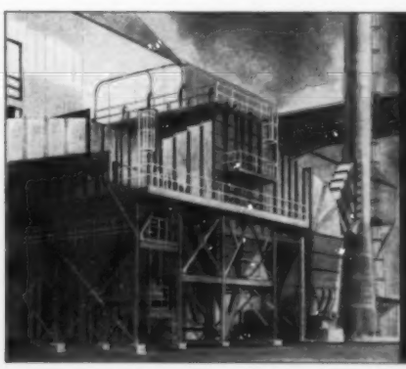


Western Precipitation LEADS in dust and fume control!

In the nation-wide Steel Industry, as in power, cement, smelting and other industries, Western Precipitation dust and fume control equipment is setting new standards of achievement. For example...

OPEN HEARTH FURNACES

At Kaiser Steel Company's Southern California Fontana operations, difficult dust and fume problems from hot metal open hearths were solved so successfully that similar Western Precipitation Cottrells are being installed on all the remaining open hearths!



SINTERING PLANTS

At a major East Coast steel plant, six CMP (Combination Multiclone Precipitator) units have so effectively reduced the dust loading that costly maintenance or replacement of fan parts from abrasion has been virtually eliminated!

ELECTRIC FURNACES

At Jones & Laughlin's Otis Works in Ohio, Western Precipitation has been given the job of installing a complete "turn-key" dust control system on J & L's electric furnaces. In addition to Cottrell Precipitators, Western Precipitation will install flame traps, flues, humidification towers, fans, stack and instrumentation—a complete "turn-key" installation!

COMPLETELY AUTOMATED SYSTEMS

At U.S. Steel's giant Homestead Works—one of the largest in the nation—Western Precipitation has been given the responsibility of designing and installing the steel industry's first completely automated dust and fume control system. Handling eleven open-hearth furnaces, the system features push-button control of gas flow and dust removal from one centralized station!

Whether your *gas cleaning problem calls for electrical precipitation* (COTTRELL) *... mechanical collection* (MULTICLONE) *... combination electrical-mechanical methods* (CMP) *... or filter* (DUALAIRE) *equipment, Western Precipitation offers the industry's greatest background of experienced "know-how" in this field. Available on a complete "turn-key" basis—or for any portion of a collection job—these facilities are ready to serve you throughout the United States, Canada and the free world!*

COTTRELL Electrical Precipitators
MULTICLONE Mechanical Collectors
CMP Combination Units
DUALAIRE Reverse-Jet Filters
HOLO-FLITE Processors

Western Precipitation Corporation

Designers and Manufacturers of Equipment for Collection of Suspended Material from Gases ... and Equipment for the Process Industries

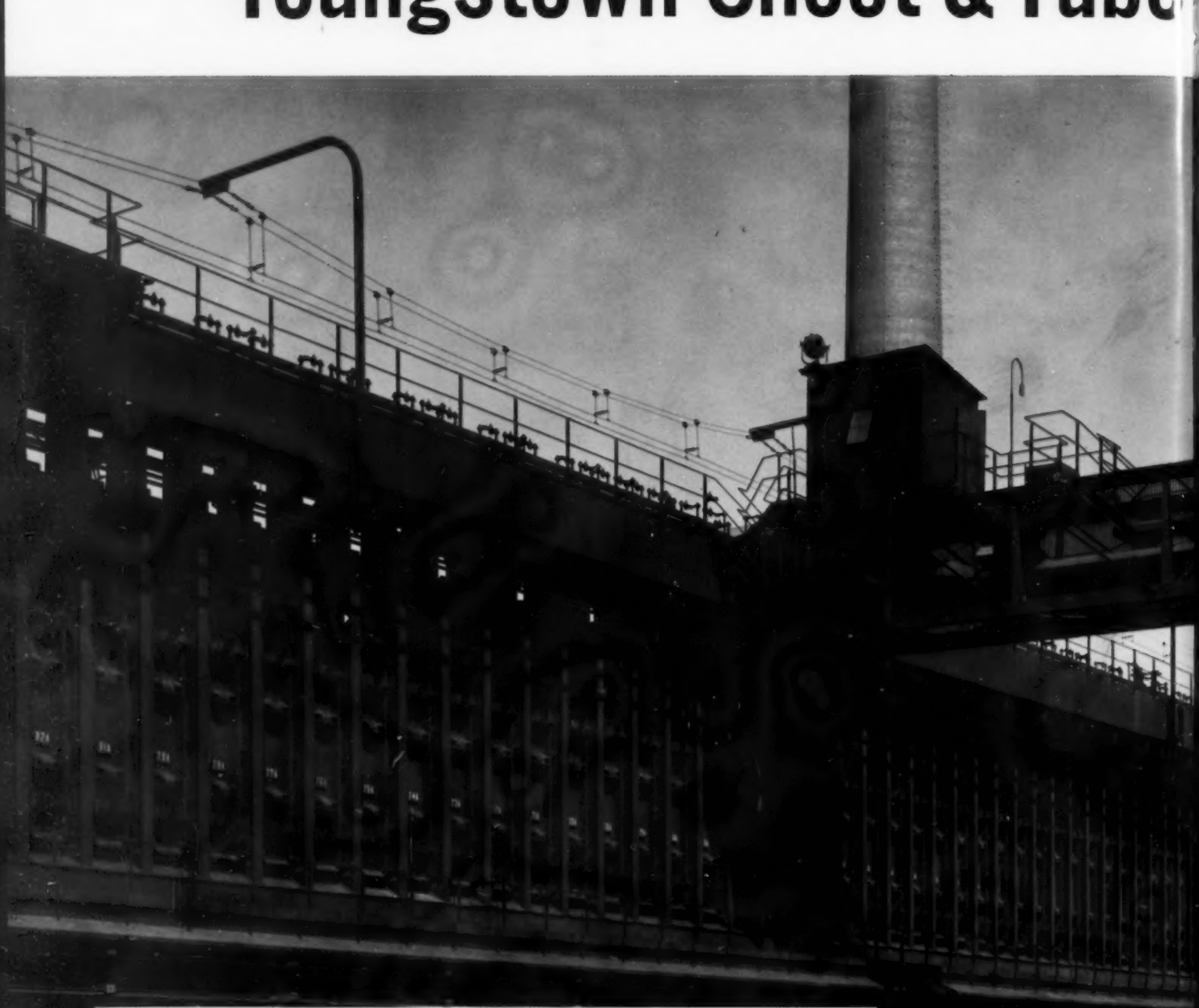
Main Offices: **1067 WEST NINTH STREET, LOS ANGELES 54, CALIFORNIA**

Chrysler Building, New York 17 • 1 North La Salle Street Building, Chicago 2 • Oliver Building, Pittsburgh 22 • 3252 Peachtree Road N. E., Atlanta 5 • Hobart Building, San Francisco 4

Precipitation Company of Canada Ltd., Dominion Square Building, Montreal

Representatives in all principal cities

Repeat order for Koppers
Youngstown Sheet & Tube



Battery No. 4—is shown in these photos of the Coke Plant at Youngstown Sheet & Tube's Indiana Harbor Works.

s Coke Ovens at the
e Company

Dependable service from existing battery leads to purchase of 75 more Koppers Ovens

BATTERY NO. 3, consisting of 75 Koppers-Becker Underjet Coke Ovens, was put into operation in 1952 at the Indiana Harbor Works. In 1955, Youngstown required additional coke-making facilities, and chose Koppers to design and construct a new battery, which is a duplicate of Battery No. 3.

2,000 net tons per day

The new Koppers battery went into operation late in 1956. Its 75 ovens carbonize approximately 2,000 net tons of coal per day. Oven walls feature Koppers patented and highly regarded Hammerhead construction. Recirculation of waste gas insures uniform heating, cuts down fuel consumption, and eliminates any need for decarbonizing equipment—an important saving.

Coke oven or blast furnace gas

Now underfired with coke oven gas, the new battery can later be fired with blast furnace gas if desired. This construction, which permits both types of gas to be used, was first developed and introduced by Koppers.

Koppers accustomed to repeat business

Koppers has built the majority of coke ovens in the United States. Much of this business, like the new battery for Youngstown Sheet & Tube, is *repeat* business—the kind you get only if your product has given satisfactory service.

We think this is a good reason for *you* to specify Koppers—not only for coke ovens, but for all other steel-plant installations. Koppers brings you 50 years of service and experience. The Coke Plant, Freyn, and Chemical Departments have done work on nearly all types of steel-making equipment. Write or call for information. Koppers Company, Inc., Engineering and Construction Division, Pittsburgh 19, Pennsylvania.

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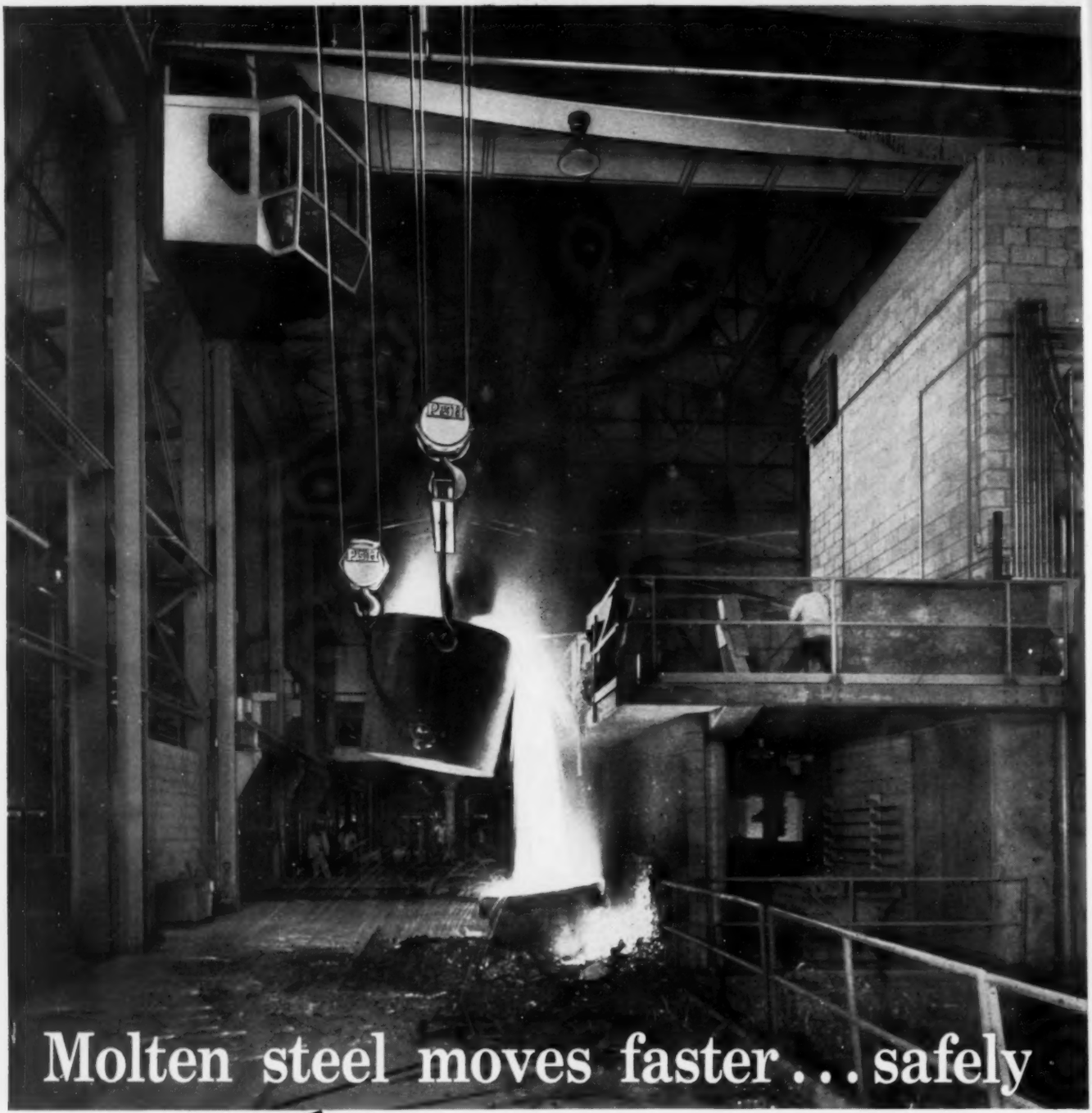
heet &

KOPPERS®

KOPPERS

ENGINEERING AND CONSTRUCTION



Molten steel moves faster . . . safely with P&H Electronic Crane Control

From furnace to casting pit, loads of molten steel glide through the air with the greatest of ease and safety — and they can be spotted on a dime, when handled with P&H electronically-controlled overhead cranes. P&H electronic control furnishes "stepless" response for infinitely variable, more precise crane operation.

A flip of the lever enables the operator to pinpoint a charge bucket into the furnace . . . to synchronize ladle positioning for tapping the heat. With the same ease, he can control the auxiliary hoist during slagging-off, then speed the molten steel to the casting pit without incident or accident.

Find out how P&H electronic crane control can speed your production and slash crane maintenance. Write Dept.125G, Harnischfeger Corp., Milwaukee 46, Wisconsin.

HARNISCHFEGER

P&H . . . *Quality and Service for 73 years*

Industry gets tons of oxygen ...*with no capital investment*

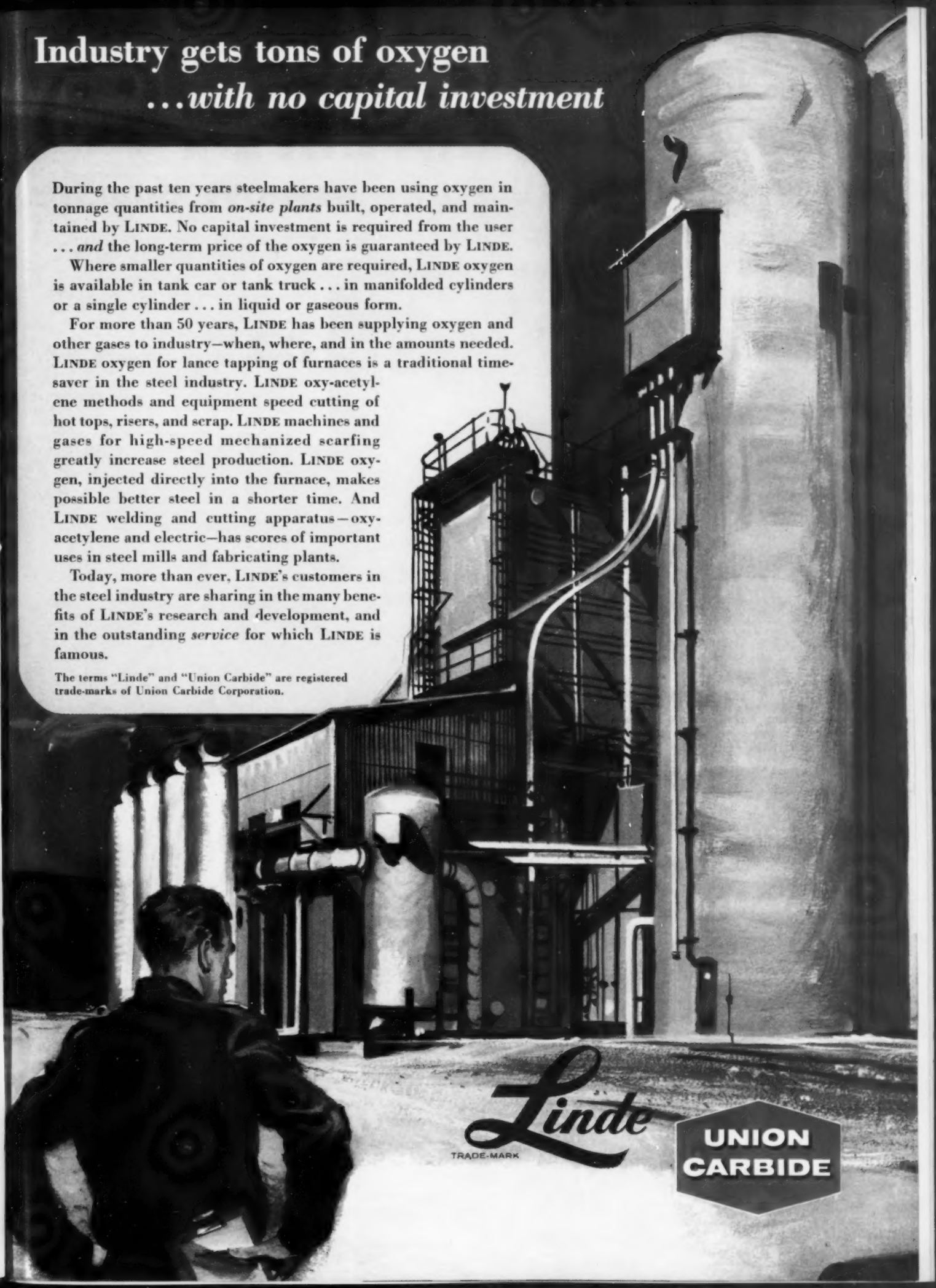
During the past ten years steelmakers have been using oxygen in tonnage quantities from *on-site plants* built, operated, and maintained by LINDE. No capital investment is required from the user ... *and* the long-term price of the oxygen is guaranteed by LINDE.

Where smaller quantities of oxygen are required, LINDE oxygen is available in tank car or tank truck ... in manifolded cylinders or a single cylinder ... in liquid or gaseous form.

For more than 50 years, LINDE has been supplying oxygen and other gases to industry—when, where, and in the amounts needed. LINDE oxygen for lance tapping of furnaces is a traditional time-saver in the steel industry. LINDE oxy-acetylene methods and equipment speed cutting of hot tops, risers, and scrap. LINDE machines and gases for high-speed mechanized scarfing greatly increase steel production. LINDE oxygen, injected directly into the furnace, makes possible better steel in a shorter time. And LINDE welding and cutting apparatus—oxy-acetylene and electric—has scores of important uses in steel mills and fabricating plants.

Today, more than ever, LINDE's customers in the steel industry are sharing in the many benefits of LINDE's research and development, and in the outstanding *service* for which LINDE is famous.

The terms "Linde" and "Union Carbide" are registered trade-marks of Union Carbide Corporation.



Linde
TRADE-MARK

UNION CARBIDE

from Furnace...to Fabrication

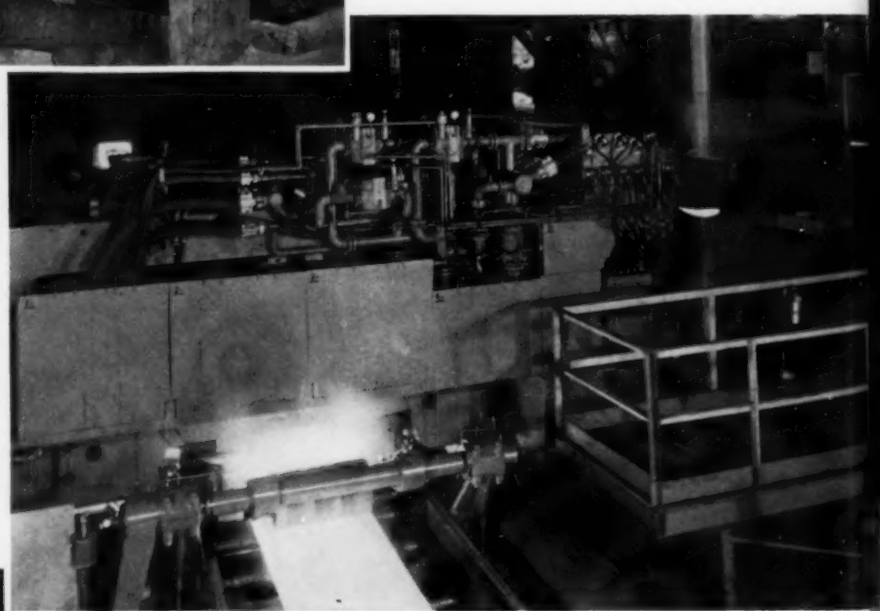
LINDE HELPS STEEL MEN SPEED PRODUCTION AND IMPROVE QUALITY

MORE STEEL FROM EVERY FURNACE

One of the most important recent advances in steelmaking is the addition of oxygen directly into the furnace. Injection of oxygen into the molten bath during the "cooking" stage helps raise steel output without building additional furnaces. Many processes are today being revised to include oxygen as a basic raw material, injected directly into the furnace. LINDE oxygen is being injected into electric furnaces, to speed production and improve the quality of stainless steel. Oxygen injection in open-hearth and blast furnaces means greater savings in fuel as well as increased ingot yield.

MACHINE SCARFING KEEPS 'EM ROLLING

Conditioning steel with the oxy-acetylene flame has brought vast improvements to steel mill operations. The savings obtained with machine scarfing, compared to hand scarfing, average from 50 cents to $4.00 a ton—and far more when compared to the costs of grinding and chipping. The mechanized LIN-DE-SUR-FACER scarfing machine—pioneered and developed by LINDE—automatically conditions steel at speeds up to 195 feet per minute, with just one man needed to control the operation.

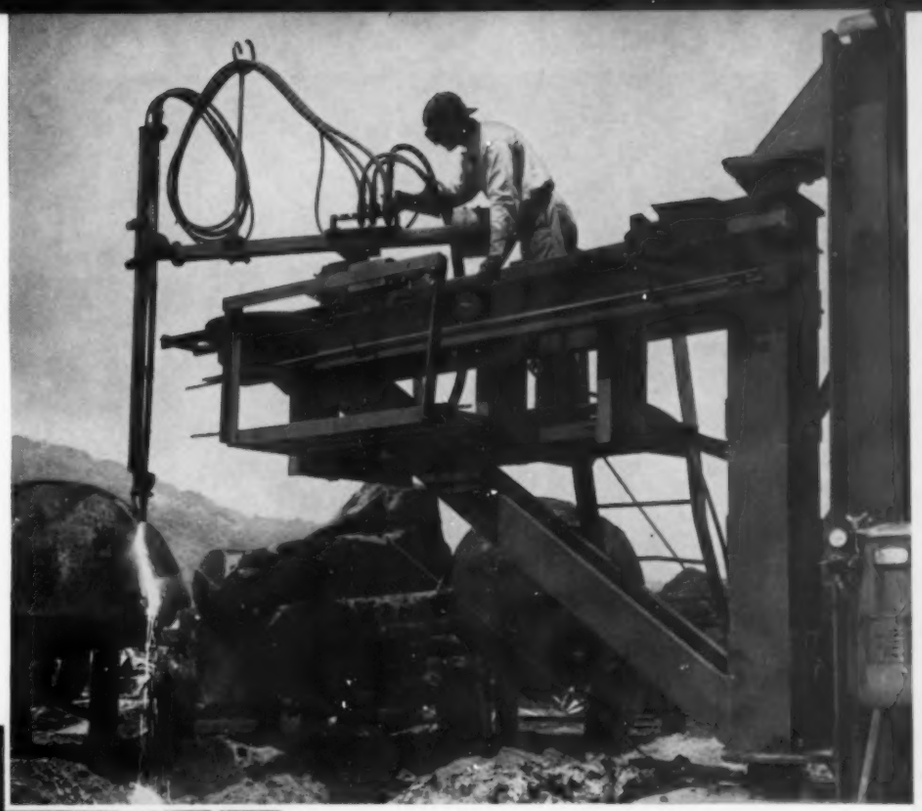


WELDING STEEL FASTER—AND MORE ECONOMICALLY

UNIONARC Welding, a new departure from conventional welding methods, is LINDE's latest contribution to the improvement of steel finishing and fabrication. UNIONARC Welding uses a continuously-fed bare wire and a magnetic flux to produce welds of superior quality—at speeds up to 300% greater than with covered electrode welding. In this photograph, the operator is using UNIONARC Welding equipment to build up shallow spots in a large casting.

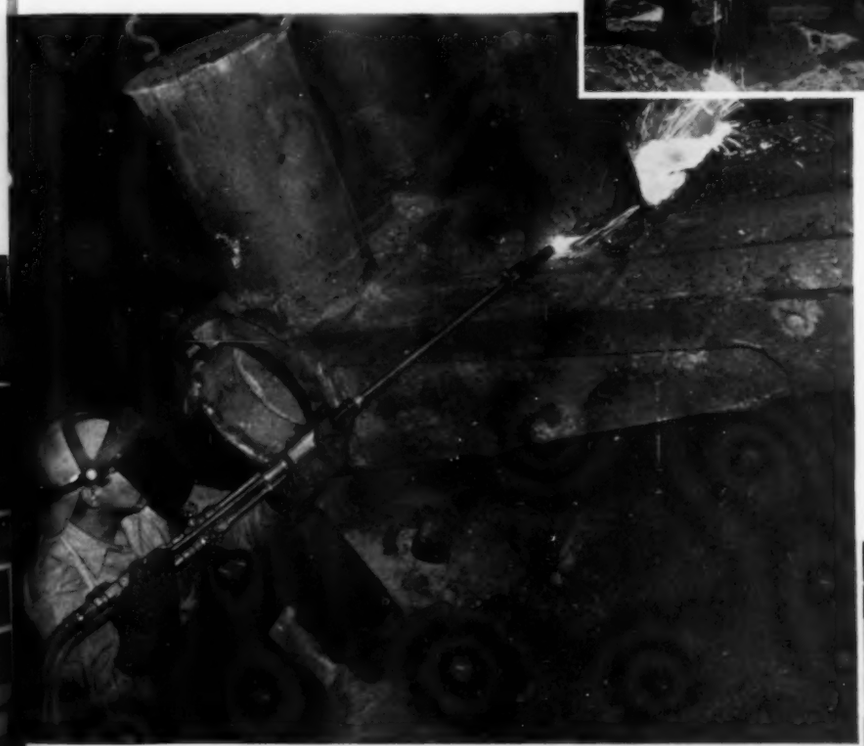
POWDER-CUTTING MAKES SHORT WORK OF SCRAP AND SKULLS

LINDE's Powder-Cutting process has proved indispensable in reducing large, hard-to-cut material to furnace charging sizes. Heavy sections, formerly discarded, are now easily and economically reclaimed as melting scrap. Here, a heavy-duty OXWELD Machine Cutting Blowpipe severs a 44-inch-thick carbon steel skull incrusted with slag and cinders.



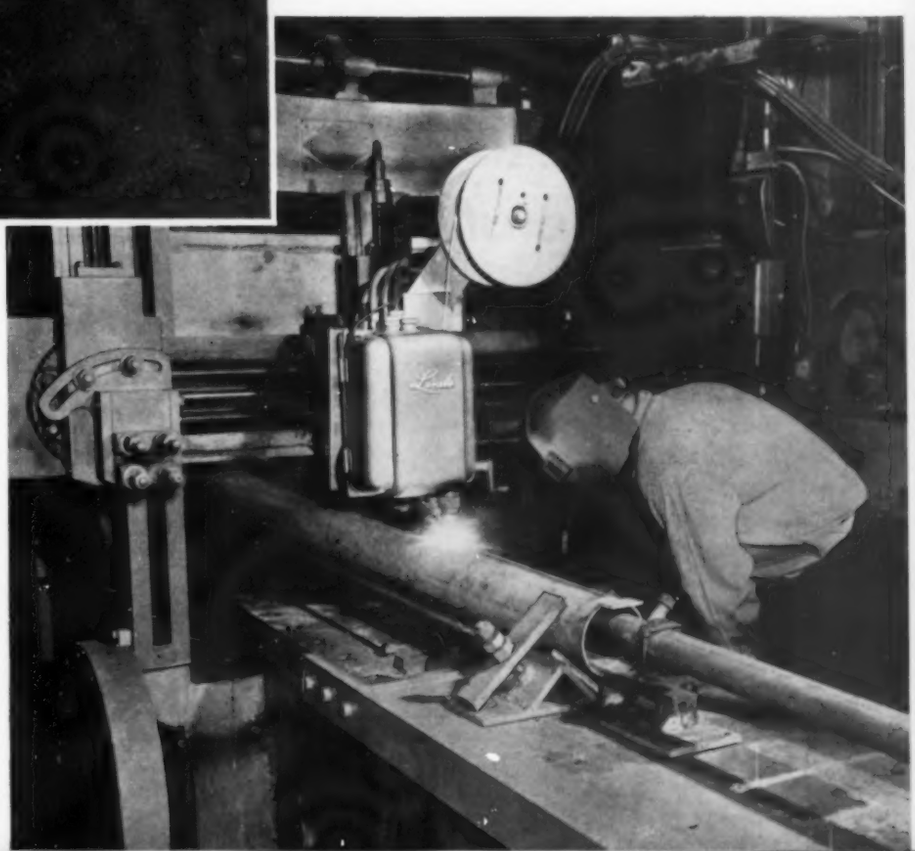
BIGGEST BLOWPIPE LOPS OFF RISERS AT ONE A MINUTE

The OXWELD C-63 Blowpipe—world's largest capacity oxy-acetylene manual cutting torch—slices through a 10-inch-diameter riser in slightly less than one minute. For years, oxygen lances made by LINDE have been standard equipment for tapping furnaces and draining salamanders. Fifty years of know-how, plus highest-quality construction, build top efficiency into every piece of LINDE equipment.



TIME-PROVED WELDING—MECHANIZED OR MANUAL

LINDE's apparatus for sigma welding has long been a valuable aid in welding. With LINDE argon as a shield, sigma welding is known throughout industry for its controlled penetration and low cost, whether automatically or manually operated. The stainless steel pipe in this picture is being seamed with LINDE equipment for sigma welding.



LINDE SERVICE FOR THE STEEL INDUSTRY

LINDE and Steel have grown and expanded together. All along the way, LINDE has helped steelmakers and fabricators to solve their problems. LINDE's extensive research and development facilities, its engineering staff, and its manufacturing facilities are always available for the benefit of the steel industry. If you wish information about any LINDE product, process, or service, please write or call your nearest LINDE office.

LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y. Offices in other principal cities. *In Canada:* Linde Company, Division of Union Carbide Canada Limited.

The terms "Linde," "Unionarc," "Lin-de-Surfacer," "Oxweld," and "Union Carbide" are registered trademarks of Union Carbide Corporation.

LINDE's method for desulphurization of iron at the blast furnace is simple, efficient, and economical. Principal units are nitrogen supply, dispenser, and injection tube.

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Metallurgical Carbide from LINDE

With LINDE equipment and UNION calcium carbide, the sulphur content of molten pig iron can be effectively and economically reduced. When you use the LINDE method, you get these advantages: No noxious fumes . . . dry slag does not attack refractory materials . . . treatment is fast, easy to operate and control . . . results are predictable and uniform.

The LINDE equipment includes a large carbide dispenser, adequate nitrogen supply, and graphite injection tube. Fine mesh carbide, carried by a stream of pressurized nitrogen, is injected deep in the hot metal. Using this LINDE method, you eliminate unnecessary pigging costs. And you can gain even greater savings by buying metallurgical carbide in bulk from LINDE.

If you would like to know more about LINDE's improved desulphurization methods and equipment, write today. LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y. Offices in other principal cities. *In Canada:* Linde Company, Division of Union Carbide Canada Limited.

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DESIGN FEATURES

- 150 ton capacity; Shell weight 38,000#
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- High efficiency box section bands and shell stiffeners for greatest strength-to-weight ratio.
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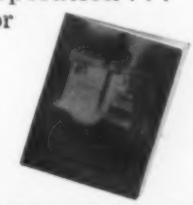
New PECor Ladle Design Increases Payload

The New PECor PAYLOAD Ladle handles 15 tons *more* payload because PECor engineers have designed 16,000 pounds OUT of the ladle. A revolutionary new design permits this drastic reduction in dead weight without sacrificing strength or requiring the use of costly high alloy material. You get 15 tons more payload with minimum dead loads, and the lowest possible cost consistent with safe practice.

For ahead-of-the-field steel plant equipment look to the leadership of Pennsylvania Engineering Corporation . . . pioneers in engineering and fabrication for more than 75 years.



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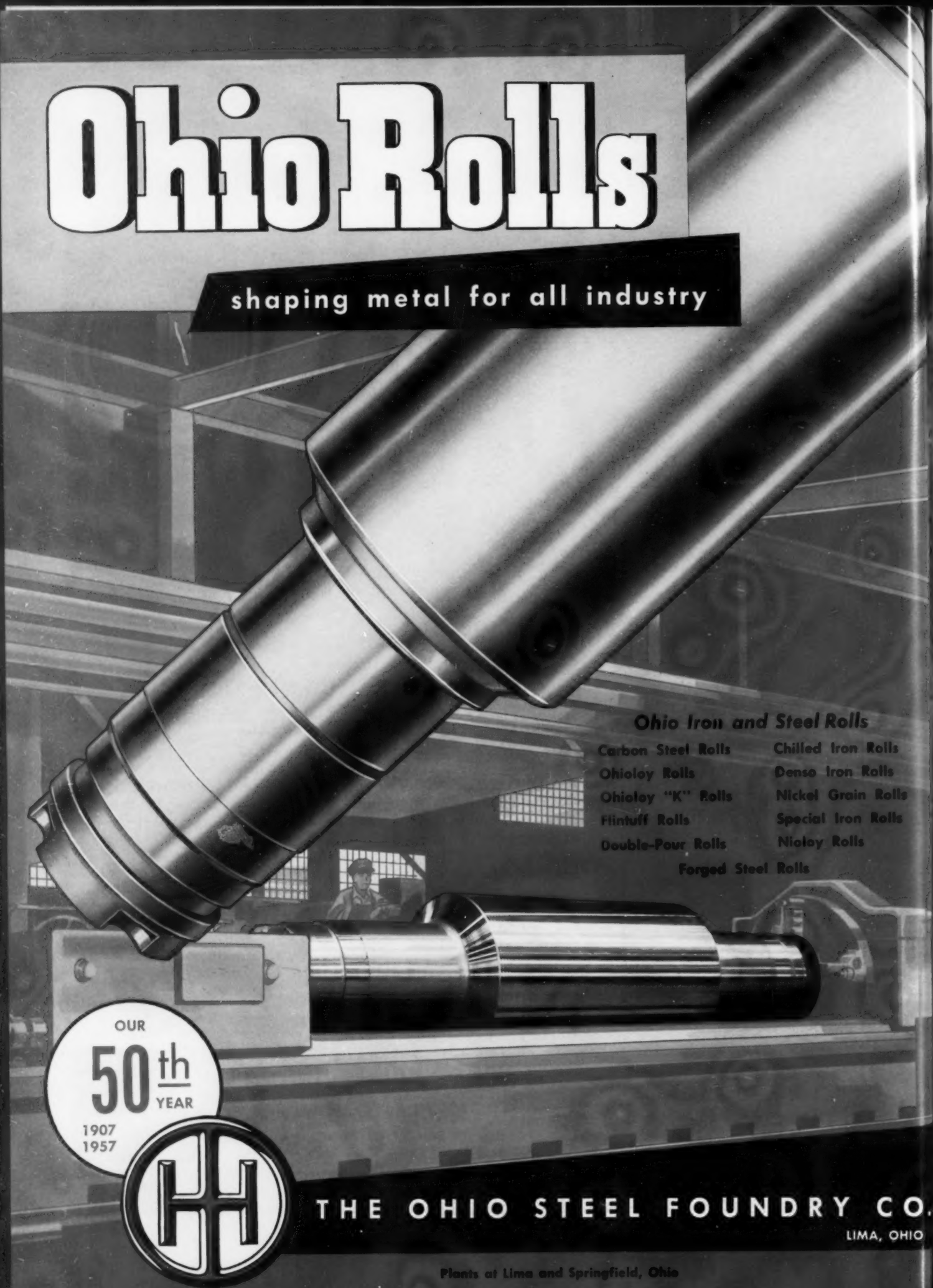
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Industry News...

INLAND STEEL TO ADD NEW SINTERING PLANT

▲ Inland Steel announced that it has contracted for construction at its Indiana Harbor Works of a new sintering plant designed to expand its ironmaking capacity by 300,000 tons a year. The new plant will have twice the capacity of the company's present sintering facilities.

The new sintering plant to be built by the Dwight-Lloyd Division of the McDowell Co., will supply material to six of the company's eight blast furnaces.

The plant will occupy about 12 acres of a new 20-acre extension to the Inland property created by filling in Lake Michigan. The main building will be approximately 300 ft long and 75 ft wide. Moving grates eight ft wide and with a total area of 1344 sq ft will be able to produce approximately 4000 tons a day of sintered ore.

The sintering plant is part of the $280,000,000 three-year program of expansion of Inland Steel, now at approximately its half way point and scheduled to lift the company's steelmaking capacity 15 per cent by the end of 1958.

REBUILT COKE BATTERY OPERATING AT CLAIRTON

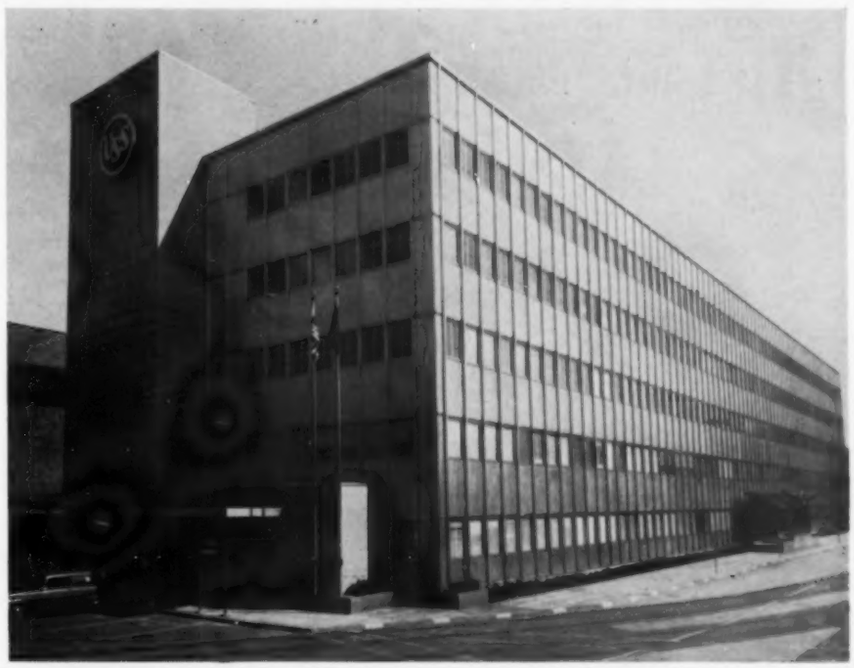
▲ Rebuilt No. 10 coke battery at U. S. Steel Corp's Clairton Works was put into operation August 17, bringing to eighteen the number of rebuilt batteries at the plant since World War II.

The post-war total will soon reach twenty with No. 11 and No. 12 batteries scheduled to be in production within a few weeks, leaving only three of the original batteries still in operation.

The Allied Chemical and Dye Corp.'s Wilputte Coke Division commenced construction of the three new batteries last year following demolition of the original No. 10, 11 and 12 batteries.

Each of the 192 new ovens making up the three rebuilt batteries measures 37 ft long, 12 ft high and 19 in. wide. Of the gun-flue type, the batteries have double collector mains for gas and coal chemical recovery. Equipped with self-sealing doors, the ovens will be served by a new quenching station and screening facilities.

BUILDING COMBINES STAINLESS AND ENAMEL PANELS



The new five-story general office building at U. S. Steel's Homestead District Works is 331 ft long and 72 ft wide housing about 800 employees. The building is of all steel construction, featuring both stainless steel paneling and porcelain enamel panels on the exterior. Floor area totals 120,000 sq ft, and cubage is 1,600,000 cu ft. It will house general suprintendent and staff, industrial engineering, mechanical engineering, industrial relations, metallurgy, production planning, transportation and accounting departments.

COMPLETES PILOT RUNS ON NEW SENDZIMIR MILL

▲ Pilot runs, which began July 22 on the new Sendzimir mill and its supporting equipment recently installed at Eastern Stainless Steel Corp.'s Baltimore, Md., plant, have been completed and the equipment is set to go into full production within the near future, according to W. F. Schneid, vice president in charge of operations.

In terms of dollar volume, the new installation is expected to increase the annual capacity of Eastern's mill by approximately 50 per cent. The corporation presently is the largest exclusive producer of stainless steel sheets and plates in the world.

Eastern's Sendzimir, a cold reducing type mill, produces stainless steel sheet up to a maximum width of 48 in. and from 0.078 gage down to a present minimum gage of 0.007 in. These thin gages held to extremely close tolerances have proven ideal in the construction of supersonic aircraft and missiles as well as for many diversified uses in other fabricating fields.

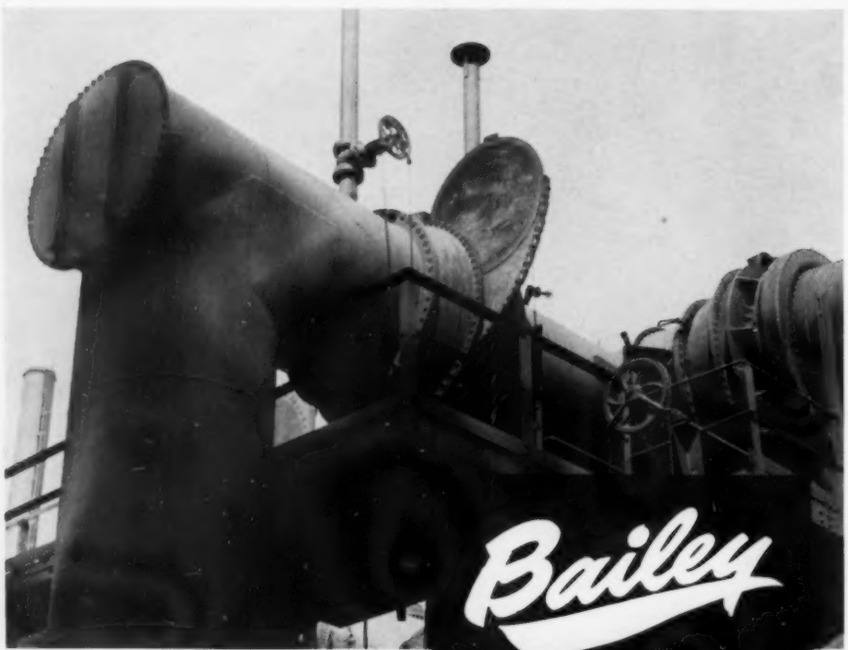
The new mill is one of the few large types now in operation in the United States. It is almost completely automatic. The supporting equipment includes annealing, pickling, edging, slitting and cold rolling. The entire operation is housed in a recently constructed addition to the plant and occupies about 39,000 sq ft of floor space. The new facilities are a part of the $8,000,000 expansion program which Eastern began two years ago.

The mill is of the reversing type with winders at each end. Heavy back tension is applied to these winders, actually stretching the sheet during the rolling process.

The entire roll assembly operates in a special oil of which there are ap-

These Goggle Plates

Operate Easily Even in Large Sizes



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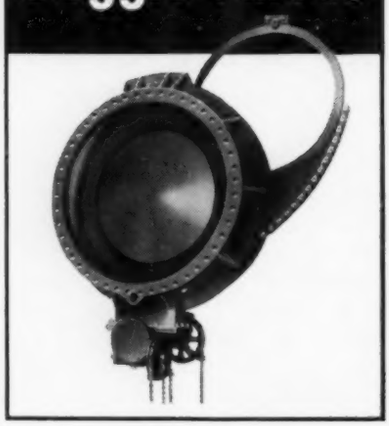
Goggle Valves



Regardless of how long they may stand unused, Bailey Goggle Plates free easily to close or open the gas main. With goggle plates either closed or open, a powerful clamping force assures a gas-tight seal—dependable protection for men and equipment.

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proximately 35,000 gallons in the complete system. The mill itself and the winders are independently driven, but carefully synchronized for speeds up to 700 fpm, by motors which total 3750 hp. This power is supplied by a 3000-kw motor generator and an intricate system of automatic controls.

When in full operation they will have a total capacity of 4000 tons of high quality stainless steel sheets and coils each month.

PHOENIX WILL INSTALL NEW OXYGEN PLANT

▲ A new half-million dollar oxygen producing plant will be installed at the Phoenixville, Pa., plant of Phoenix Iron & Steel Co., William A. Cook, president of the company and a vice president of the parent company, Barium Steel Corp., announced.

Ground will be broken for construction this month, and the plant is expected to be operative sometime next spring. The oxygen plant will have a monthly capacity of 7½ million cu ft and will have duel generators, permitting maximum flexibility and reliability.

The new unit will lower operating costs, according to Mr. Cook. It will also make more oxygen available for scarfing pipe mill ingots, for fabricating applications in the Phoenix Bridge Co. (a subsidiary of Barium), and for open hearth operations.

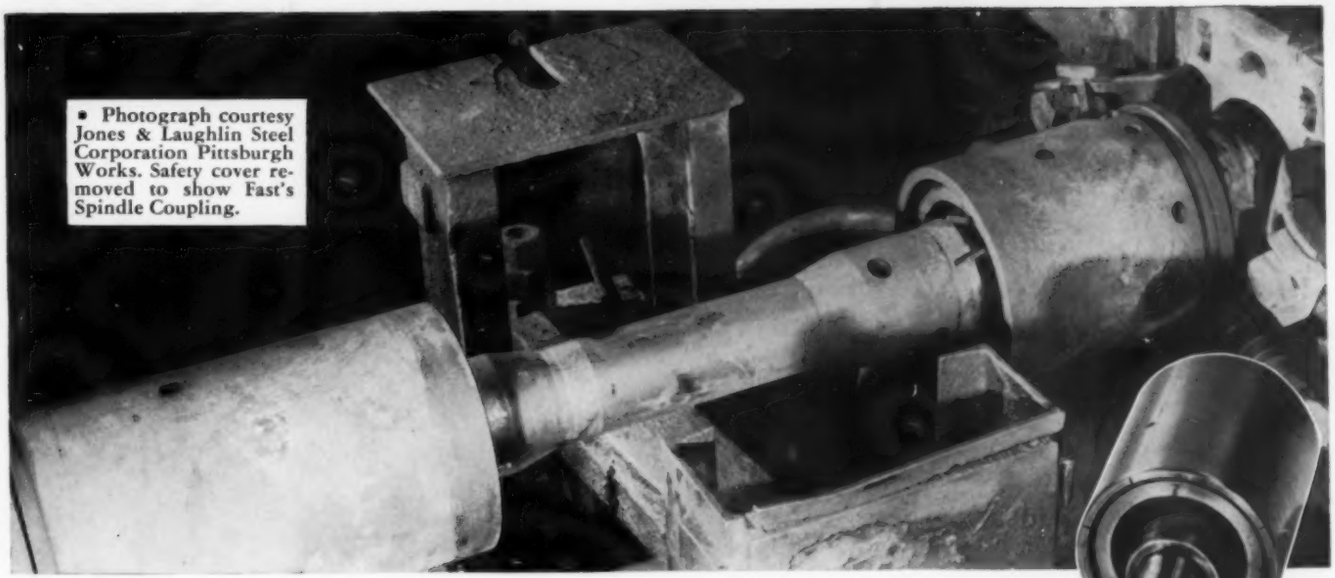
Experience with the oxygen unit will determine whether or not a similar unit will be installed at the company's Harrisburg plant.

Air Products, Inc. will install the unit and instruct company personnel in its operation.

ITALIAN FIRM AWARDS CONTRACT TO KOPPERS

▲ Koppers Co., Inc. has been awarded a contract for the design, procurement and construction supervision of a blast furnace for ILVA, Alti Forni E Acciaieri D'-Italia of Genoa, Italy.

This is the second contract awarded by this Italian subsidiary of "Finsider," a financial group operating a number of steel companies representing about 52 per cent of the steel production of Italy. The new blast furnace will be constructed by the steel firm at its plant at Piom-



• Photograph courtesy Jones & Laughlin Steel Corporation Pittsburgh Works. Safety cover removed to show Fast's Spindle Coupling.

Fast's Spindle Couplings Mean More Profitable Rolling Mill Operations

★ *Up to 50% Less Down-Time*
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The quick-disconnect and reliability features of Fast's Spindle Couplings may reduce down-time as much as 50%. Figured in dollars, this permits savings in production time in most rolling and blooming mill applications which can amount to thousands of dollars a month.

The new tooth configuration of Fast's Spindle Couplings compensates for a relatively high amount of misalignment with a minimum of backlash. It also permits constant angular velocity of the rolls which results in a marked improvement in the quality of the end product. Fast's Spindle Couplings are made of all steel construction with a metallic segmented conformable seal . . . completely self-contained and self-lubricated. They withstand the most rugged operating conditions, giving years of trouble-free service with only a minimum of maintenance.

Koppers' 38 years of experience in the coupling industry guarantees the right coupling engineered for a given application. To solve your rolling mill coupling problem write to KOPPERS COMPANY, INC., Fast's Coupling Department, 3009 Scott Street, Baltimore 3, Maryland.

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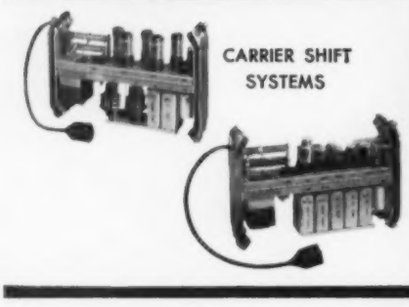
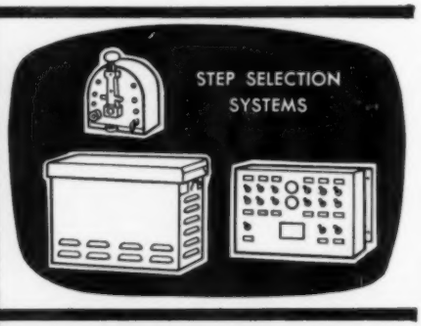
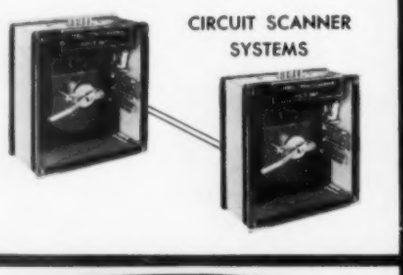
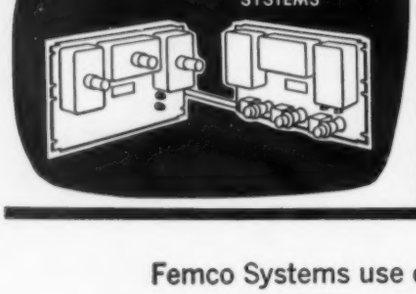
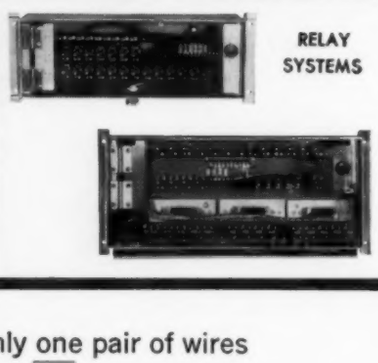
with standard components, we can provide control and indication for many purposes.











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COMMUNICATION • Electronic Engineers • AUTOMATION

bino, Italy. The first Koppers blast furnace is being constructed at the firm's Bagnoli Plant near Naples.

The Freyn Department of Koppers Engineering and Construction Division was awarded the contract through Koppers International Division.

When the blast furnace, which will have a hearth diameter of 22 ft, is completed, it is estimated that it will produce approximately 1000 net tons of pig iron per day. The new furnace will increase the production capacity of the Piombino Plant by more than 50 per cent. ILVA operates two other blast furnaces at the Piombino Plant, each with a capcity of 800 net tons per day.

NATIONAL CARBON CO. COMPLETES EXPANSION

▲ A $50-million, seven-year industrial expansion program adding nearly 100,000 tons of annual productive capacity at plants throughout the country has been completed by National Carbon Co., Division of Union Carbide Corp., Adger S. Johnson, president of National Carbon Co., announced.

"Completion of our second major industrial expansion since World War II has geared our productive facilities for carbon and graphite to the growing needs of the industries we serve," Mr. Johnson said. "For the first time in a number of years we now have sufficient productive capacity to take care of industry's normal anticipated requirements, barring a national emergency, for several years to come. Heavy spending during the past few years has made it possible to provide modern industry with carbon and graphite products of the size and quantity it now requires, and will continue to require in the future.

COMPANY EXPANDS ITS PITTSBURGH OFFICES

▲ Western Precipitation Corp. has recently expanded both the services and personnel of its Pittsburgh offices.

The territory served by the Pittsburgh offices has been expanded to include western Pa., western Md., all of W. Va. and eastern Ohio. Additional personnel has also been added to the Pittsburgh staff for

servicing this area. In addition, the facilities of the Pittsburgh office have been augmented so that dust and fume control applications in the power, cement, chemical processing, mining, metallurgical and other industries can be handled.

AMERICAN GILSONITE CO. NAMES REPRESENTATIVE

▲ Wilson Petrolcoke & Carbon Corp. has been appointed sales representative for the new metallurgical coke produced by the Colorado refinery of American Gilsonite Co.

The company will handle all foreign and domestic sales of Gilsonite coke to electrode, carbide and steel manufacturers and to the aluminum industry abroad. Coke sales to the aluminum industry in the United States and Canada will be handled directly by American Gilsonite Co.

Gilsonite coke is an extremely pure grade of metallurgical coke containing a maximum of only 0.25 per cent sulphur. The coke is produced from Gilsonite, a solid hydrocarbon, mined by American Gilsonite Co. in eastern Utah. In addition to high purity coke, the refinery produces gasoline. It is the first U.S. refinery to produce petroleum products from raw materials other than crude oil.

ASSOCIATION NAMES MANAGEMENT COUNCIL

▲ At a meeting held in Buffalo, N. Y. Unilock International Association, an organization of firms in the United States and Canada using a method of cold metal repair (Mechanical Insert) named a council of management.

Named to the council were R. Rectenwald, Maintenance Engineering Corp., Pittsburgh, Pa., William Scott of Herculock Limited, Niagara Falls, Ontario, and George Jackman of Metal Locking Service, Inc., Buffalo, N. Y.

The meeting was under the guidance of Cale B. Jarvis, controller of Unilock International. The number of councillors ultimately would be five (4 American and 1 Canadian), and the two remaining American positions will be filled shortly.

The appointments are the first concrete steps toward the formation of a North American association of firms using this process. The asso-

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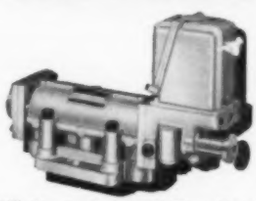
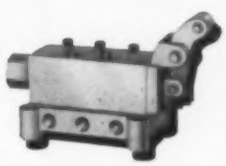
AIR AND HYDRAULIC
Control Valves

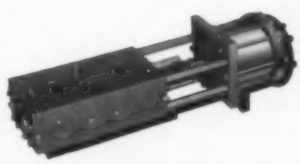


½" Single Solenoid Two Position 4-way "B"-type Valve, for Pressures up to 250 psi.



¼" 4-way Cam Operated Spring Return Valve, for Pressures up to 125 psi.

½" 2 Pedal Foot Operated 4-way Valve, for Pressures up to 200 psi.



1" Pilot Cylinder Operated 4-way Two Position Hydraulic Valve, for Pressures up to 5000 psi.

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Many steel companies obtain low-cost oxygen from dependable Air Products generators in many combinations of quantity, purity and pressure.

We produce: package, tonnage and custom-built oxygen and nitrogen generators. Check with us for detailed information on a dependable and continuous supply of low-cost oxygen. Air Products, Incorporated, P.O. Box 538, Allentown, Pa.

Air Products ...INCORPORATED

Weirton Steel...

... put three 2,000 cfh oxygen generating plants (total—4,000,000 cf/month)—built by Air Products—into operation over eleven years ago. Since that time, Air Products has met the increasing needs for oxygen at Weirton by supplying additional oxygen facilities (up to the present 335,000,000 cf/month total capacity).

This continuity of a low-cost supply of oxygen over the years has been possible only through the use of dependable "on-location" generators—designed and manufactured by Air Products.

Continuity of supply at Weirton is a typical benefit resulting from steel companies' use of "on-site" oxygen generators. Other steel companies enjoy such profitable advantages as: substantial reductions in oxygen cost ... dependable production of high purity oxygen 24 hours/day ... flexibility in meeting increased or decreased demand through proper equipment sizing. Even plants requiring limited quantities of oxygen can profitably use Air Products generators.

Let us show you how you can have a dependable low cost supply of oxygen without capital investment. Air Products "on-site" oxygen generators supply many of the nation's leading steel plants. We'd like to talk to you about them ... your inquiry is invited. Air Products, Incorporated, P.O. Box 538, Allentown, Pa.

Air Products ...INCORPORATED

ciation is being patterned after that of the Metalock International Association, which presently is active in 30 countries throughout the world.

Such an association has long been desired by North American users of this cold repair process, and the benefits to individual members are unlimited.

ROLLING MILL CONTRACT IS AWARDED TO MESTA

▲ The Mesta Machine Co. has been awarded a contract covering the design and manufacture of a 46 in. two-high reversing slabbing-blooming mill and auxiliary equipment. The installation will be made at the Duquesne Works of the United States Steel Corp., and will replace rolling mill equipment now in operation. This mill will roll steel slabs and blooms from ingots weighing up to approximately 20 tons.

The contract will include two ingot buggies, ingot turnaround and weighing scale, 46 in. x 105 in. slabbing-blooming mill with manipulator, slab and bloom shear with gage, slab pusher and piler, tables and lubricating systems. The design of the mill will be such that automatic program control can be added in the future.

AMERICAN BRAKE SHOE ACQUIRES CANADIAN FIRM

▲ Dominion Brake Shoe Co., Ltd., has acquired all the physical assets and business of Manitoba Foundries and Steel, Ltd., in a cash transaction, it was announced jointly by Kenneth T. Fawcett, president of Dominion Brake Shoe, and H. O. Jones, president of Manitoba Foundries.

Dominion Brake Shoe is a subsidiary of American Brake Shoe Co., and Manitoba Foundries has been a wholly-owned subsidiary of Vulcan Iron and Engineering, Ltd.

ANNOUNCE MERGER OF ENGINEERING FIRMS

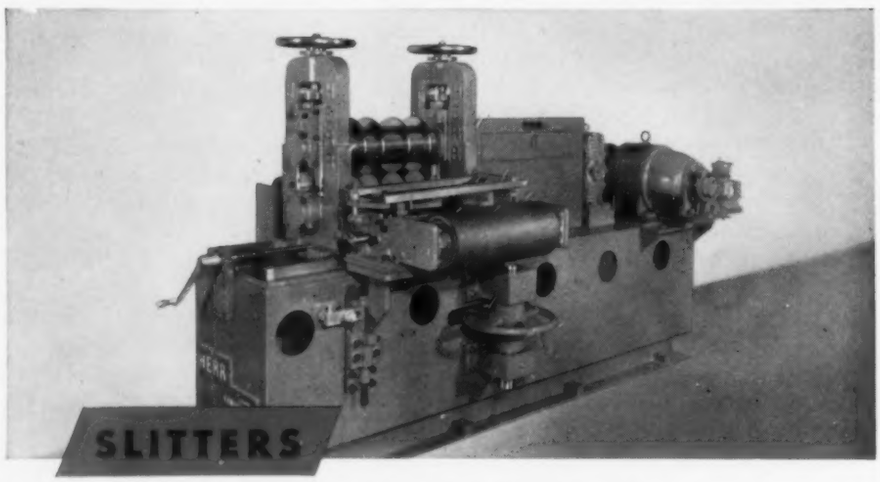
▲ Ritter Engineering Co. and Dudley C. Jackson Inc., of Pittsburgh

ALUMINUM MILL ROLLS FOIL INTO COILS

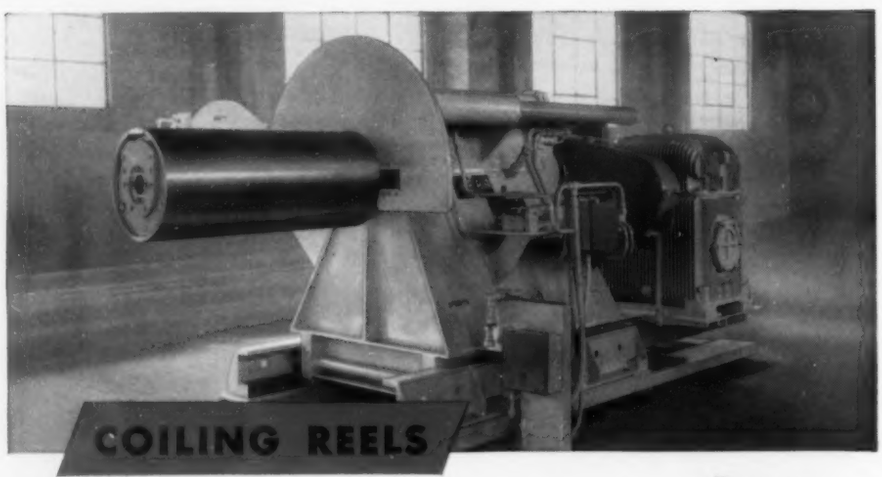
In the foreground are coils of aluminum strip rolled down to foil gages—0.00024 in. thick—at the St. Louis plant of Johnston Foil Co. In the background is a new intermediate breakdown aluminum foil mill. Designed and built by Blaw-Knox Co., the mill is a 10 and 31 by 62-in. four-high unit, capable of rolling at speeds up to 1200 fpm, on aluminum with a starting thickness of 0.102 in. and a final finish thickness of 0.004 in. The handles on the panel behind the operator control valves which feed mineral coolant to the work rolls on the mill. The mill has selective thermal control in addition to hydraulic roll crown control. Hydraulically-operated loading and unloading buggies handle the coils before and after rolling.

HERR EQUIPMENT

"Complete Processing and Handling Equipment . . . for any Ferrous or Non-Ferrous Material . . . That Starts — or Ends — as a Coil"



Built to insure dependable, high precision slitting. All thicknesses from .001 to ⅛", any commercial width. Quick, extremely accurate knife set-up. Also complete high precision slitting lines including pay-off reel, leveler, slitter, scrap winder, scrap chopper and coiling reel.



Wide variety of types and sizes for coiling ferrous and non-ferrous strip. Fixed, adjustable or automatically aligning bases. Automatic oscillating level winding drive if desired. Link type contracting mandrels; manually or hydraulically operated. Furnished complete ready for use.

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THE HERR EQUIPMENT CORPORATION

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CLEVELAND, INDIANAPOLIS AND BERKELEY, CALIFORNIA

and Chicago respectively, merged their operations on August 15. Both companies are application engineering houses and distributors for Trabon Engineering Corp. and Parker Appliance Co. The company will operate under the name of Ritter Engineering Co. with the Chicago operation being designated as the Jackson Division.

Trabon Engineering Corp. manufactures centralized lubricating systems and circulating oil systems for industry. Parker Appliance Co. manufactures fluid system components.

SALEM-BROSIUS AWARDED SOAKING PIT CONTRACT

▲ Acme Steel Co. has awarded a contract for three batteries of soaking pits to Salem-Brosius, Inc.

The pits will be rectangular, dual-fuel and top-fired, with four pits per battery. They will be similar in design to other recent installations made by Salem-Brosius in the Pittsburgh and Chicago areas.

Acme Steel will use the pits in conjunction with a new melt shop of the oxygen converter type. The complete unit is scheduled to be in production by the fall of 1958.

TO BUILD GAS CLEANING SYSTEM FOR MCLOUTH

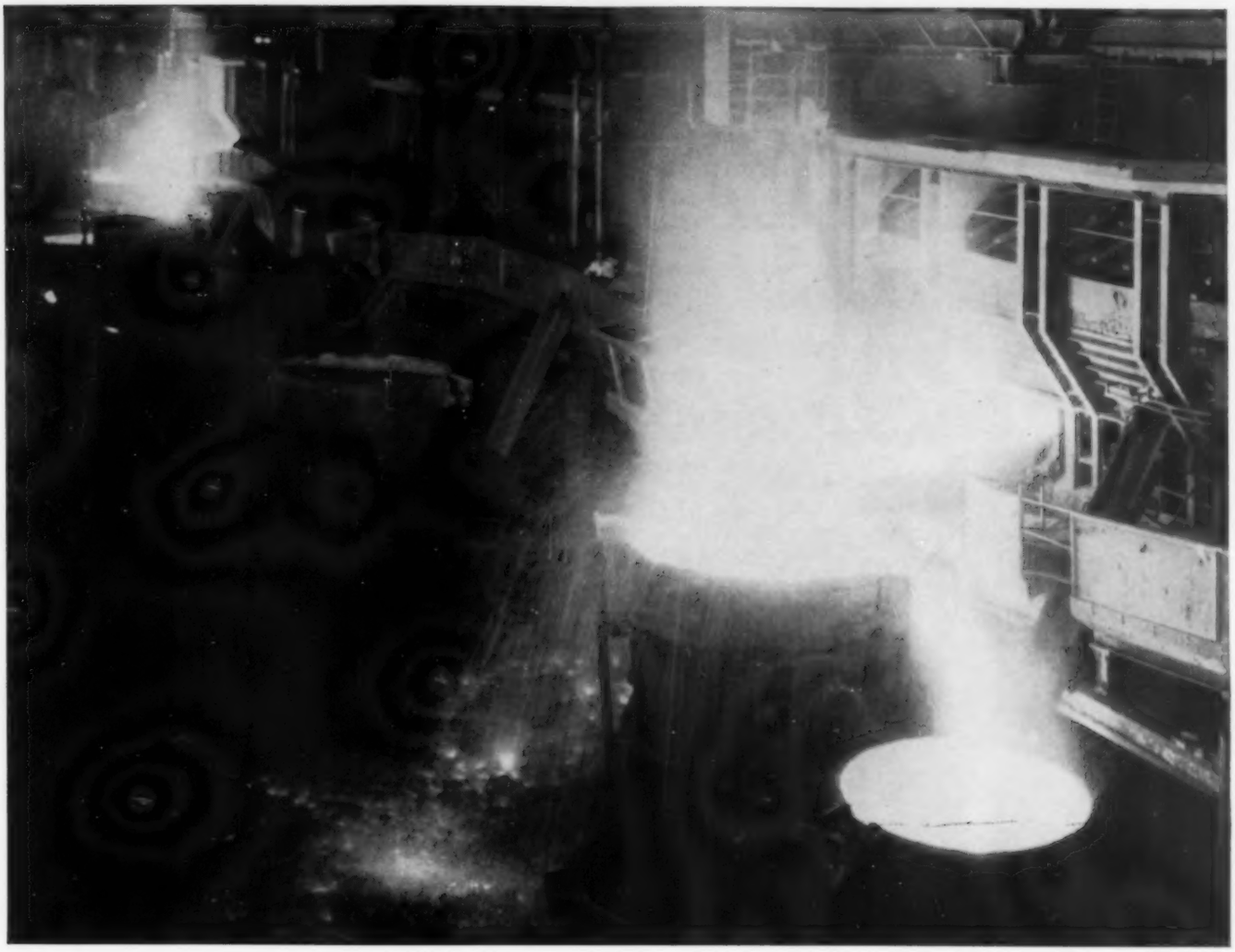
▲ McLouth Steel Corp. has awarded Koppers Co., Inc. a contract to design and install a gas cleaning system at its plant at Trenton, Mich.

Designed by the Freyn Department, the gas cleaning system is for McLouth's newest oxygen process steel installation. This is the second such system Koppers has designed for the steel firm. The previous gas cleaning system has been in use since it was constructed in 1953 and cleans gas from an oxygen converter and six electric furnaces.

INSUL-MASTIC ACQUIRED BY PITTSBURGH COKE

▲ Assets of the Insul-Mastic companies of Summit, Ill., producers of industrial protective coatings, have been purchased by Pittsburgh Coke & Chemical Co.

The newly-acquired facilities, located near Chicago, will continue production of the Insul-Mastic line



Increase production of your existing open hearths

We concur with the opinion of many steel plant operators that modernization of existing open hearth facilities represents an economical and often overlooked way to materially boost annual tonnage—with a minimum capital investment.

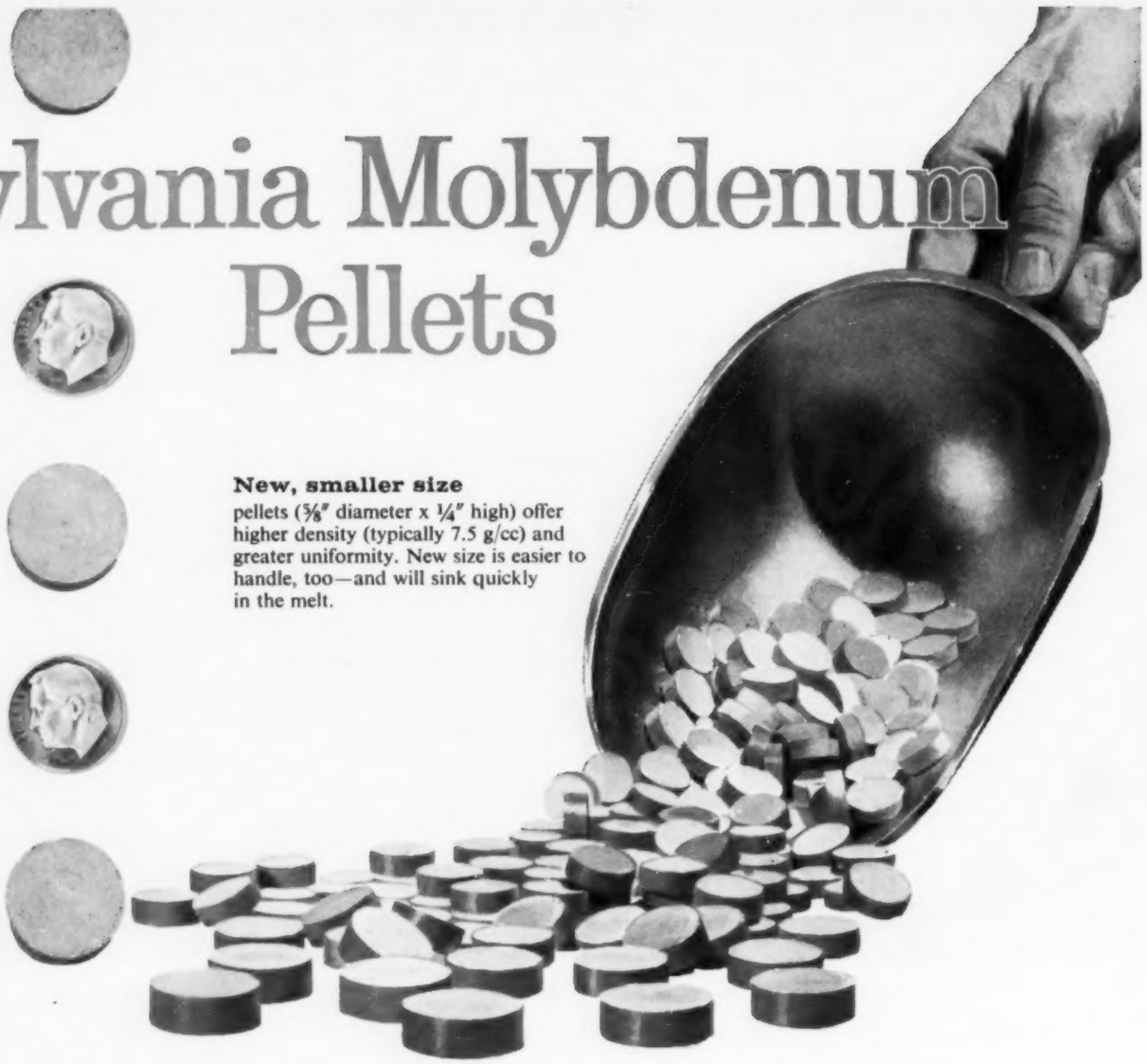
The required modification of present furnaces to assure a substantial increase in production involves a thorough design study—not only of hearth size or capacity, but also with respect to all other essentials of furnace structure from burners to stack. We have successfully completed a great number of such projects, and will welcome an opportunity to make a complete review of your steelmaking facilities.

From first heat to heat treat, look to **LOFTUS**
Engineering Corporation

1 Gateway Center, Pittsburgh 22, Pa.
140 S. Dearborn St., Chicago 3, Ill.

57.17.7

Sylvania Molybdenum Pellets



New, smaller size
pellets (⅜" diameter x ¼" high) offer higher density (typically 7.5 g/cc) and greater uniformity. New size is easier to handle, too—and will sink quickly in the melt.

—the new form manufactured to specified purity and composition

Sylvania Molybdenum Pellets are designed and manufactured specifically for use in vacuum melting. They provide a readily available source of the best purity molybdenum (typical 99.85%) available on the market. Detrimental impurities are at an extremely low level. This consistent high purity simplifies the calculation of additions to each melt as the usual variations of purity and gas content are eliminated.

By maintaining a high density, the gas content of the pellets is kept well below that acceptable for vacuum melting. In addition, the compact uniform size of the pellets facilitates weighing and charging to the melt.

When you use Sylvania Molybdenum Pellets, you benefit in other ways, too. Their continuous availability means you can plan your production schedules on a long-range basis. Further, their pricing stability permits you to price your own product without having to worry about fluctuating raw materials costs.

Call your Sylvania representative or write for details.

SYLVANIA ELECTRIC PRODUCTS INC.
Tungsten and Chemical Division, Towanda, Pa.

TUNGSTEN • MOLYBDENUM • CHEMICALS • PHOSPHORS • SEMICONDUCTORS

SYLVANIA

LIGHTING • RADIO • ELECTRONICS • TELEVISION • ATOMIC ENERGY

of asphaltic coatings and insulating materials for sale through the parent company's Protective Coatings Division. The Insul-Mastic sales organization will be integrated with the Division's sales force.

Insul-Mastic products are primarily thick asphaltic based mastics. They are designed to prevent atmospheric and industrial corrosion above ground, and in applications where moisture and vapor barriers are required on insulation.

WEAN MANUFACTURING EQUIPMENT IN FRANCE

▲ The Wean Engineering Co. Inc., has started manufacturing equipment of Wean design in France.

In association with Messrs. Damiron & Cie., who have represented Wean for many years, a new company has been formed, Wean-Damiron, incorporated in the form of a French societe anonyme, with equal shares owned by the American and French companies. This new company has assumed the manufacture and sale of many items of equipment designed and sold by The Wean Engineering Co. Inc., Wean Equipment Corp., and The McKay Machine Co.

The designs of the equipment of the American companies will be maintained by Wean-Damiron, which will be responsible for the adaptation of the American standards to the European standards. In the case of spare parts intended to replace original parts, the American standards will be adhered to so as to assure interchangeability.

Wean-Damiron has made arrangements for the manufacture of the equipment with Ateliers et Chantiers de la Seine-Maritime at LeTrait. The manufacture and assembly of the machines at LeTrait is being done under the supervision of engineers of Wean-Damiron.

President and general manager of Wean-Damiron is Paul Damiron, and the assistant general manager is R. L. Allshouse.

RUBBER ROLL FIRM BEGINS PRODUCTION

▲ Rubber Rolls, Inc., a plant designed specifically for the production of rubber-covered rolls for industry, is in production. Located in Meadow Lands, Pa., the plant is

2-Roll SUTTON Straighteners

Manufactured under license from Sir James Farmer Norton & Co., Ltd., of Manchester, England

FOR PRECISION STRAIGHTENING, SIZING AND POLISHING OF METAL BARS FROM ⅛" to 9" DIA.

Accurate end-to-end straightening and sizing is achieved in one pass. Special roll designs make these machines ideally suited for straightening and polishing turned bar stock. Available in seven sizes for all modern metals.

Model No. 5
(Pictured)
2-Roll Sutton Straightener
for Bars from
2¼" to 7½" Dia.

Flexible—Easy to adjust for a wide range of sizes.

Dependable—Design backed by Farmer-Norton's 45 years' experience.

Ruggedly built—Sutton Universal Joints for trouble-free operation.

Ask for complete data

SUTTON *Engineering Company*

FIRST NATIONAL BANK BLDG., PITTSBURGH 22, PA.
PHONE: GRANT 1-8077 PLANT: BELLEFONTE, PA.

Manufacturers of Straighteners, Hydraulic Extrusion Presses, Centerless Bar Turners, Rotary Swagers, Sheet Levellers and other Finishing Machines for Modern Metals.

convenient for prompt service to all types of industry in the area. Industrial Rubber Products Co., located at 505 Magee St., Pittsburgh, Pa., is the distributing organization for Rubber Rolls, Inc.

Officers of the company are: Frank J. Kelly, president; V. P. Graziano, vice president; Miss Ann M. Wasel, treasurer; and Miss Muriel A. Laughrey, secretary.

Robert M. Junker, formerly of the Goodyear Tire and Rubber Co. is general manager of the plant. Prior to his resignation from Goodyear, Mr. Junker was manager of the tank lining and industrial roll department

Henry C. Robison, Sr., is general superintendent, and has been in charge of the construction of the plant. For many years Mr. Robison was associated with the Castle Rubber Co., in Butler, Pa.

ANNOUNCES CHANGE OF COMPANY NAME

▲ Chicago Concrete Breaking Co. and Chicago Concrete Construction Co. have been consolidated into one organization, hereafter to be known as the Edward Gray Corp.

Robert A. Gray, President of The Edward Gray Corp. in making the announcement pointed out that the selection of the new company name is in tribute to the man who founded Chicago Concrete 36 years ago.

Mr. Gray also reported the following named officers: Edward Gray, chairman of the board; H. D. Putnam, vice president; Walter Gray, treasurer; S. D. Lieberman, director of purchases; Edward Dolan, comptroller.

TO MERGE SUPERIOR AND COPPERWELD STEEL

▲ A plan to merge Superior Steel Corp. with Copperweld Steel Co. was agreed on "in principle" by directors of both companies August 26. The merger would be effected by the issue of ¾ of one share of Copperweld common stock in exchange for each share of Superior common stock.

In a joint announcement, Frank R. S. Kaplan, board chairman and James M. Darbaker, president, of Copperweld and Carl I. Collins, president of Superior, said that no changes in personnel are contemplated. The business conducted by Superior will be continued after the merger as the Superior Steel Division of Copperweld with Mr. Collins as vice president in charge of that division. Other present officers of Superior will occupy appropriate mangement positions in the Superior Division.

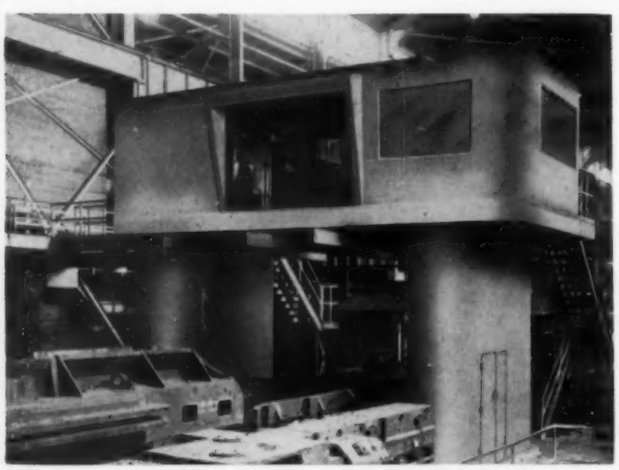
The facilities of the merging companies complement each other; and together with the facilities recently installed by Copperweld at its Warren, Ohio Steel Division will provide an added diversification of both products and markets.

The formal merger agreements will be approved by the two boards in the near future and will be put before the stockholders of both companies at special meetings to be announced at a later date.

Meetings

▲ "Refractories in Steel" will be one of the sessions to be held at the 10th Annual Regional Convention, American Ceramic Society, to be held at the Palace Hotel in San Francisco, Calif., October 16-19.

MODERN MILL OPERATOR'S PULPITS



Quiet — Comfortable — Safe
Shipped as a Complete Unit

by the originators

For new mills and replacement of existing pulpits.

Where Used

INGOT BUGGY, MAIN MILL, BILLET MILL, SLABBING MILLS, ROUGHING MILLS, FURNACE CONTROL, WIRE MILLS, SCARFER, SHEAR, INSTRUMENT. ROOMS AND MILL OFFICES. ANY PULPIT MAY BE EQUIPPED WITH AIR CONDITIONING REST ROOM FACILITIES, WATER COOLERS, OPERATORS' POSTURE CHAIRS, DESKS AND CONCEALED CONDUITS.

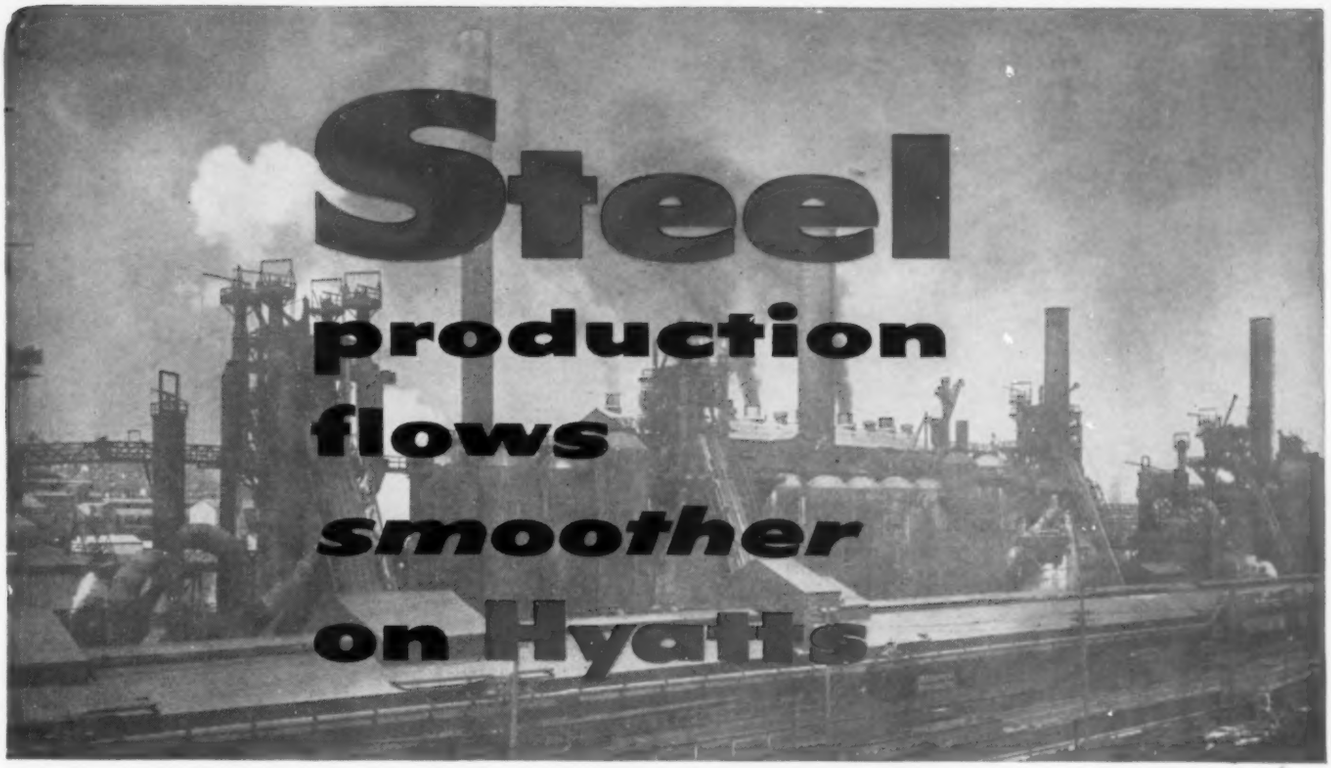
JAMES CAMPBELL SMITH INC.

Engineers and Fabricators of Quality Products for 40 years.

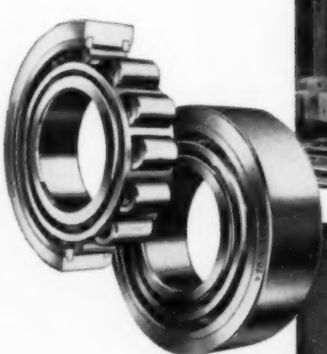
Box 64, Willoughby, Ohio **Tel. WH 2-1300**

All Products Are Unconditionally Guaranteed.

WRITE FOR "THE MARK OF QUALITY"



-from ingot cars to runout tables!



HYATTS are the No. 1 choice on ingot cars for easier starting, spotting, longer life.

For years, wherever blast furnaces blaze and rolling mills rumble, HYATT Roller Bearings have been building an unsurpassed reputation in the steel industry. And today's HYATT Hy-Roll Bearings are better than ever—thanks to ultra-modern electronic equipment which assures even greater precision.

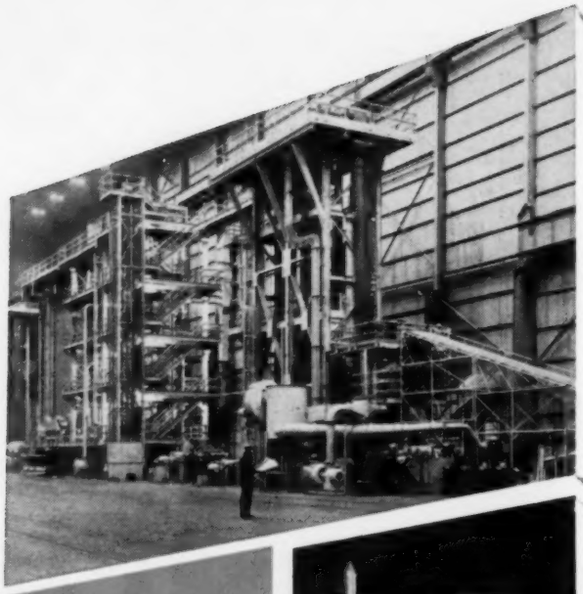
The millions we're investing in better bearing production can help save you thousands in better bearing performance. Insist on HYATT Hy-Rolls—every time! Hyatt Bearings Division of General Motors, Harrison, New Jersey.

This blooming mill set records with HYATTS on lineshaft, main, approach, runout tables.

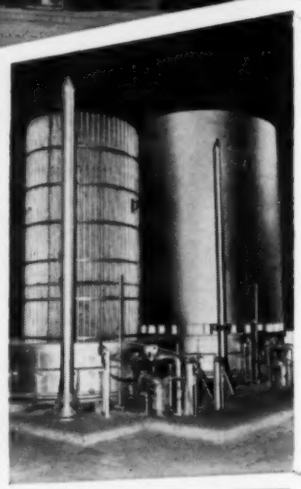
things run smoother on . . .

GM GENERAL MOTORS

HYATT HY-ROLL BEARINGS FOR STEEL INDUSTRY



VERTICAL STRIP ANNEALER



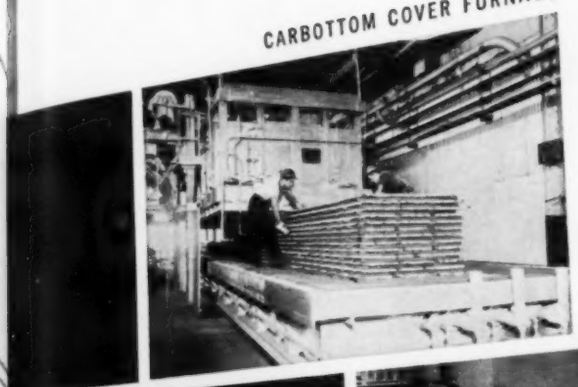
SINGLE-STAND ANNEALERS

CONTINUOUS STRIP GALVANIZER

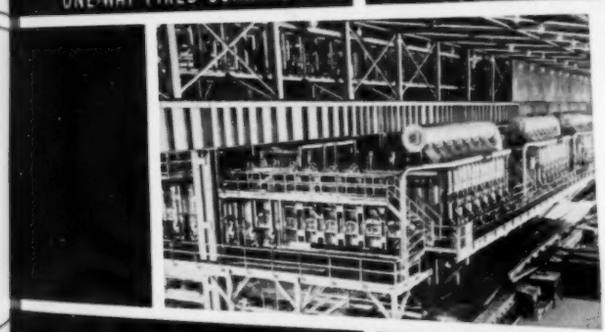
MULTIPLE-STAND ANNEALERS

foundation for steel mill profits

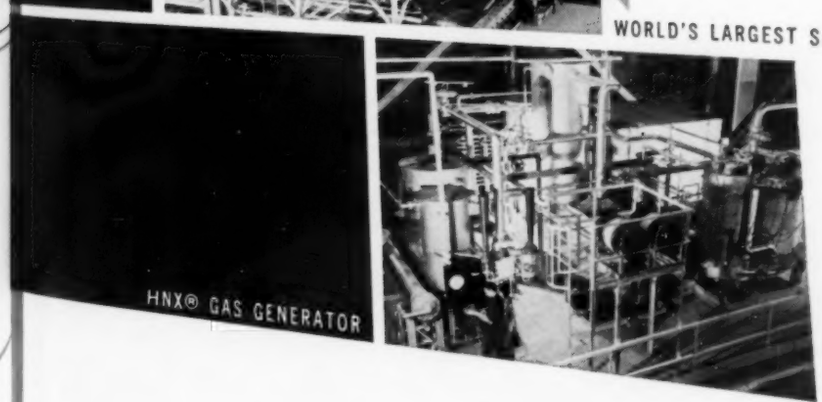
CARBOTTOM COVER FURNACE



ONE-WAY FIRED SOAKING PITS



WORLD'S LARGEST SLAB HEATER



HNX® GAS GENERATOR

You put a solid foundation under your profits whenever you specify Surface equipment. Whatever type it may be, you know it is supported by many interlocked blocks of know-how in heating and handling steel.

The technical skills which Surface has developed in building soaking pits will benefit the man who buys Surface annealing covers. In the same way, Surface concepts of slab heating contribute to high-speed stress relieving . . . carbon restoration to strip annealing . . . controlled atmospheres to wire patenting.

Because of this broad and deep foundation of experience, Surface can improve any single process in the context of a complete sequence of operations. This is to the customer's profit, as many companies will confirm.

Surface Combustion Corporation, 2404 Dorr St., Toledo 1, Ohio. In Canada: Surface Industrial Furnaces, Ltd., Toronto, Ontario.

Surface®

wherever heat is used in industry

ASSOCIATED COMPANIES: British Furnaces, Ltd., Chesterfield • Stein & Atkinson, Ltd., London • Stein & Roubaix, Paris • S. A. Belge, Stein & Roubaix, Bressoux, Liege • S. A. Forni Stein, Genoa • Chugai Ro Kogyo Kaisha, Ltd., Osaka • Benno Schilde Maschinenbau, A. G., Bad Hersfeld

An Entirely New Concept

15,000 LB. MODEL

Greatest stability at every stage of 120 inch lift

Dotted line above shows how Automatic Elbolift's built-in retraction feature maintains maximum stability every inch of its 120" lift. Tilting action illustrated is operated by a single control lever which can tilt and/or lift load separately or simultaneously.

AUTOMATIC TRANSPORTATION COMPANY

Division of The Yale & Towne Manufacturing Company

101 West 87th Street, Chicago 20, Illinois

in Fork Lift Truck Design...

Automatic ELBOLIFT!

12,000 TO 20,000 LBS. CAPACITIES

Eliminates Mast Assembly...Weighs 6000 lbs. less than any comparable mast-type truck...is definitely superior in stability, maneuverability, and operator vision.

370% More Visibility: Picture at left dramatically illustrates the increased visibility over conventional, mast-type, heavy duty trucks. Forks completely visible when entering pallet.

Drive tires two-thirds of Elbolift's width: 32 lineal inches of the truck's 48″ overall width are in contact with the floor for the greatest load distribution and stability.

All conventional ideas of fork lift trucks were scrapped in designing this newest in the long, distinguished line of Automatic "firsts." Only in this way could Automatic engineers achieve the marked improvement in capacity, maneuverability, safety, performance and weight reduction which they had set as their goal.

The result is a truck with capacities from 12,000 to 20,000 lbs. —15,000 lb. model 48″ wide, and 143″ long (less forks) is actually *three tons lighter than any comparable mast-type truck.* This permits the Elbolift to operate on floors that would be unsafe for other types of comparable capacity.

Its unique design is also responsible for other advantages ...among them the following:

Exclusive New Power Steering Control—takes the guess work out of steering. *Operator always knows* the exact direction of his steer wheels by the position of the steering lever.

Shortest Inside Turning Radius—does more work, handles heavier loads in less space. Operates easily in 13′8″ right angle aisle and 78″ boxcar door with 52″ square load.

Highest Lift With Lowest Overall Height—Elbolift has 79″ overall height with a 120″ lift.

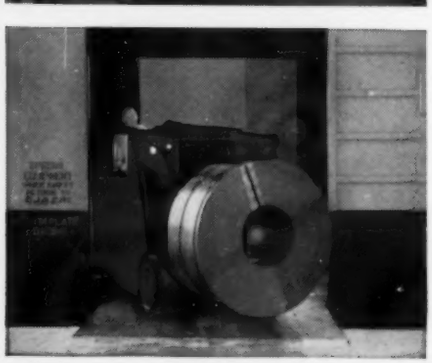
Safety—Easy on—easy off. Operator completely protected by counterweight on both sides and heel plate in the rear. Dead man control...returns speed controller to neutral and automatically applies brake when driver dismounts.

Exclusive New Inching Control—4 speeds forward and reverse with foot inching to any preset or selected speed.

Battery Accessibility—battery on rollers for quick and easy removal from either side.

But there's ever so much more than can be adequately described here. Why not get the whole story? No obligation. Just mail the coupon below...mail it today.

Maneuverability: Carrying a full load of 15,000 lbs. (52″ square), the Elbolift passes easily through any 78″ boxcar door...will right angle stack a 52″ load comfortably in a 13′8″ aisle.



Versatility: Ram attachment at left can be quickly and easily replaced by adjustable forks for handling dies, pallets, etc.

AUTOMATIC TRANSPORTATION COMPANY
47 West 87th Street, Dept. P-7, Chicago 20, Illinois

Rush me fully illustrated descriptive brochure on the revolutionary new Automatic Elbolift Trucks.

Your Name_____ Title_____

Firm Name_____

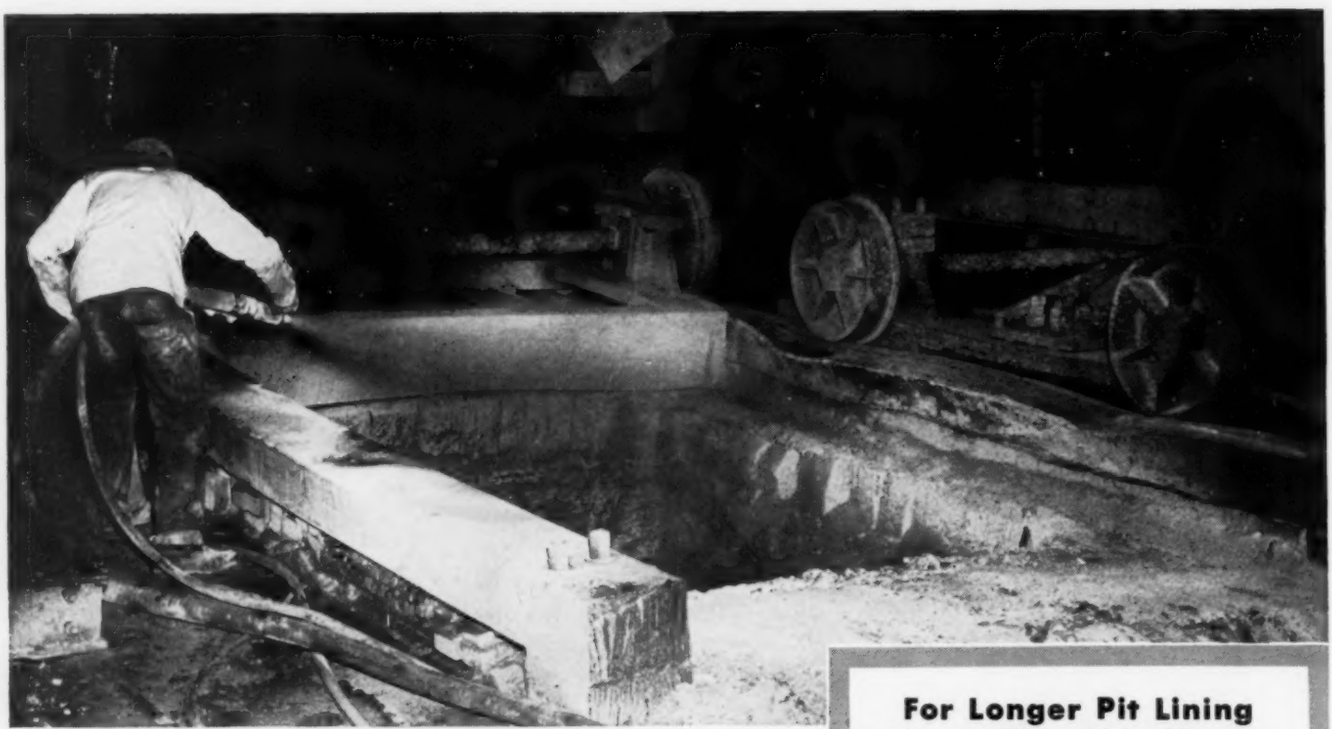
Address_____

City & Zone_____ State_____

PROVED...

Longer Life for Soaking Pit Sidewall Linings with . . .

WALSH HOT PATCH CEMENT SP



Applying Walsh Hot Patch Cement SP with spray gun on soaking pit sidewalls and coping in Midwestern Steel Plant.

"Periodical Spraying of Soaking Pit Sidewalls Increased Service Life 20% to 25%," Reports Midwestern Steel Plant

Now, through the installation of a regular maintenance program and with a minimum of man hours, you can successfully hot patch your silica and semi-silica soaking pit sidewalls for increased service life.

Walsh Hot Patch Cement SP, applied in successive coatings of approximately ½" with high pressure air gun, reduces downtime, cuts fuel cost and increases length of pit service for truly sensational savings. If you want to increase production and save money in the process, you'll be interested in having full particulars, available through your nearest Walsh representative. Or, simply write us.

Packed in dry form in 100 lb. bags.

For Longer Pit Lining Life Follow This Simple Installation Procedure

- Remove ingots from pit
- Turn off fuel
- Apply Walsh Hot Patch Cement SP with high pressure air gun to the thickness of approximately ½"
- Return ingots to pit
- Put furnace back in service

In cases where a second application is required—first allow initial coating to be burned in for 20 to 30 minutes at operating temperature of pit, then apply second coat.

WALSH REFRACTORIES CORPORATION — America's Best Clays

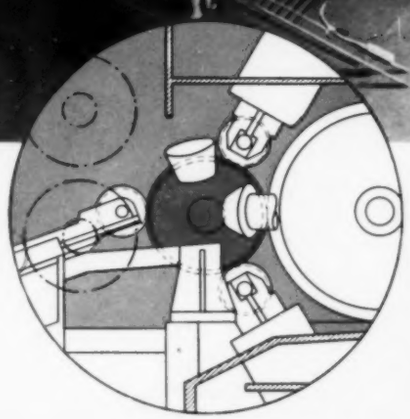
WALSH REFRACTORIES CORPORATION

101 FERRY STREET • ST. LOUIS 7, MISSOURI

FOR OVER 60 YEARS MANUFACTURERS OF HIGH GRADE REFRACTORIES

SCHLOEMANN

Solid Wheel Rolling Mill



High quality solid wheels and wheel discs in one heat

The rolling of unpunched blanks simplifies the manufacture of solid wheels, wheel discs, etc. Only two presses are required, and normally there is no necessity for a reheating furnace or special punching device. Because of the uniform and etficient shaping, excellent quality of products is obtained.

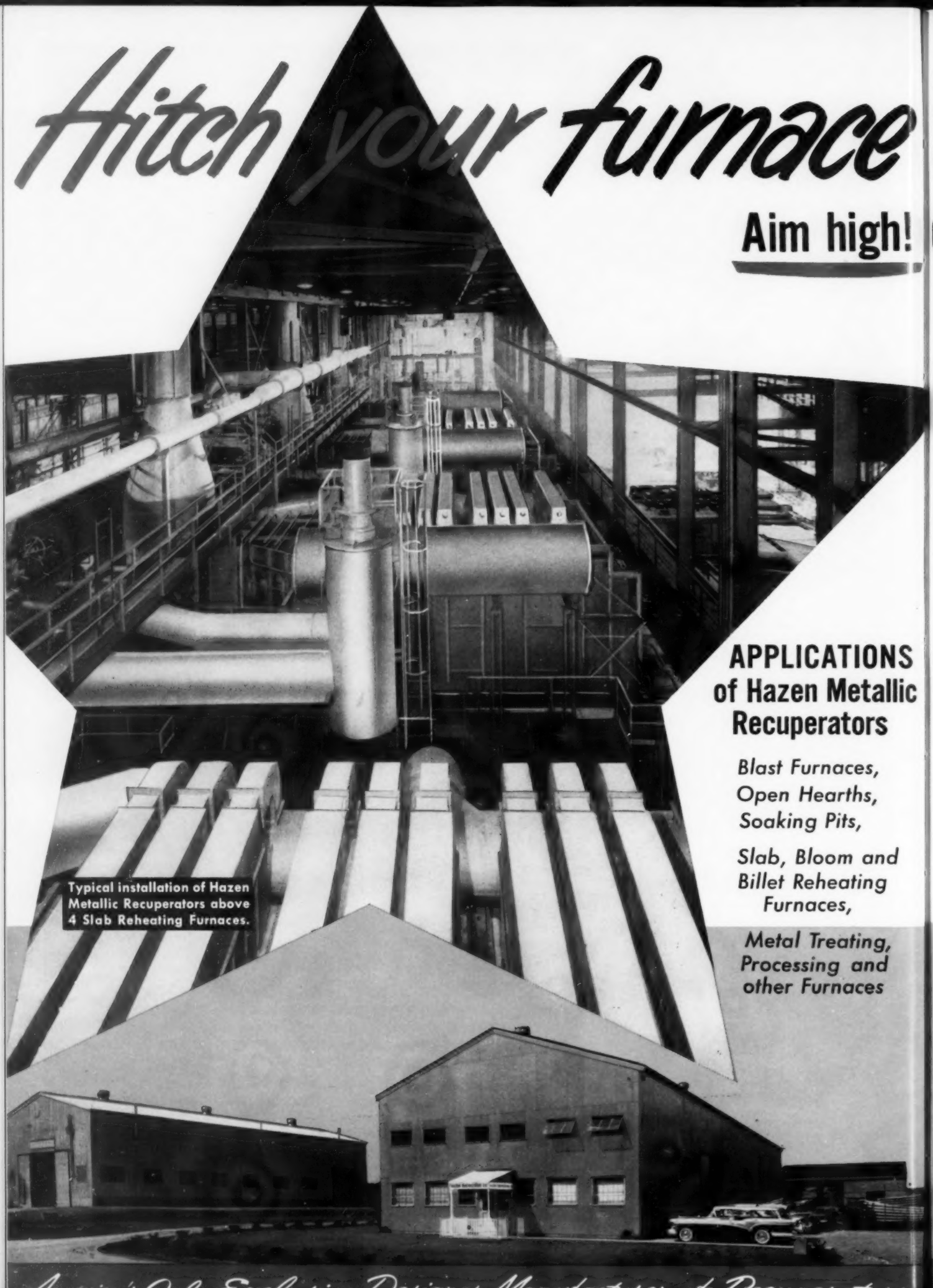
Left: System of guide rolls without mandrel provides a three-point support for the wheel and keeps it in the vertical position allowing the scale forming during the rolling operation to drop off freely.

FELLER ENGINEERING COMPANY 1161 Empire Building, Pittsburgh 22, Pa.

HOT AND COLD ROLLING MILLS · COUNTERBLOW HAMMERS · HYDRAULIC PRESSES

Hitch your furnace

Aim high!



Typical installation of Hazen Metallic Recuperators above 4 Slab Reheating Furnaces.

APPLICATIONS of Hazen Metallic Recuperators

Blast Furnaces,
Open Hearths,
Soaking Pits,

Slab, Bloom and Billet Reheating Furnaces,

Metal Treating, Processing and other Furnaces

America's Only Exclusive Designer-Manufacturer of Recuperators

to a star ☆☆☆☆☆☆

Gain topmost increase in tonnage and fuel economy

HAZEN Metallic RECUPERATORS

... the only proven furnace accelerator

- ☆ Star performer in plants of leading steel companies.
- ☆ The only 100% American Metallic Recuperator . . . inner and outer tubes made of stainless steel.
- ☆ Top Value—not by first cost alone but in terms of greater usage life and economy of furnace production.
- ☆ The Recuperator responsible for changing the trend in the steel industry from refractory to metallic design.
- ☆ The Recuperator that provides maximum preheat in keeping with the great longevity of metallic elements.
- ☆ Designed to meet the most severe flue-gas temperature conditions . . . controlled automatically.

Your mill capacity depends on furnace capacity. The Hazen Metallic Recuperator accelerates furnace heating capacity . . . It is the only recuperator of its kind backed by years of experience. It has an outstanding record for increased furnace production with reduced fuel costs. Aim high . . . get the best . . . hitch your furnace to the star of metallic recuperators—HAZEN.

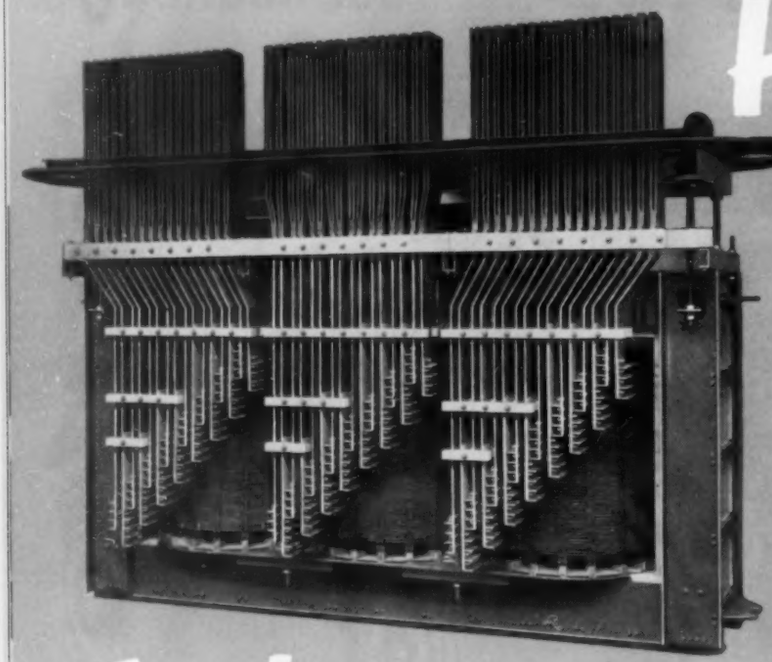
If your furnace capacity is retarding your mill capacity, get in touch with us.

HAZEN ENGINEERING COMPANY

184 Sandy Creek Road (Penn Hills) • P.O. Box 10597, Pittsburgh 35, Pa.

Telephone CHurchill 2-1750

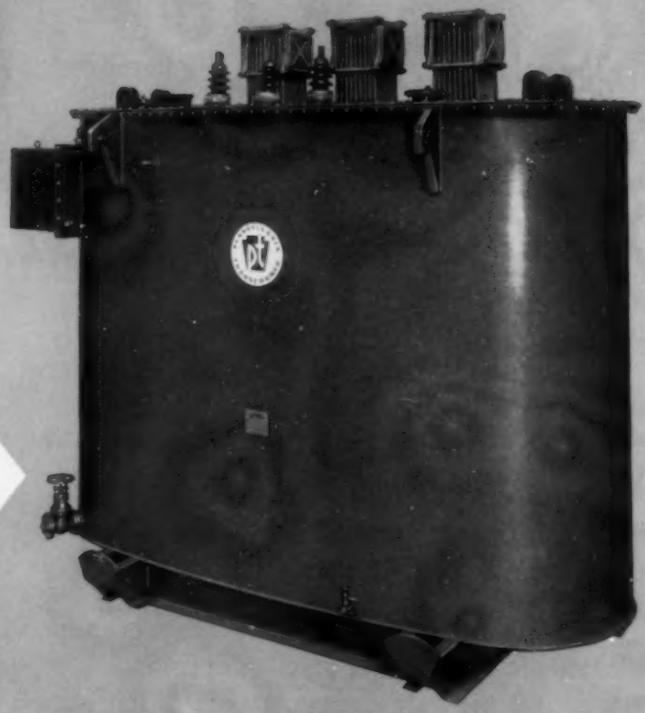
what are your FURNACE TRANSFORMER requirements?



High Current?

The 82,000-ampere low voltage line current for which this Pennsylvania Furnace Transformer is designed is one of the highest current ratings ever provided for a furnace transformer in this country. The transformer is rated at 16,000/21,300 kva. High voltage: 13,200△ volts. Low voltage: 250△ volts with a full-capacity tap range in 10-volt steps down to 150 volts.

Fast Delivery?

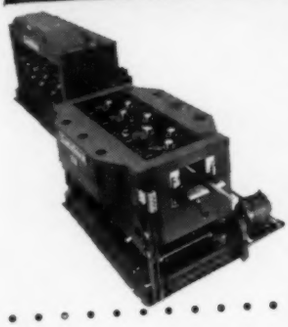


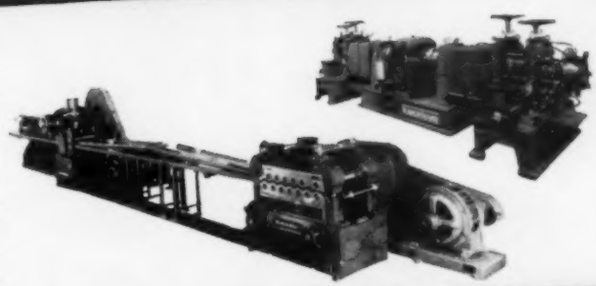
Only **20 calendar days** were required to build and ship this 25,000-kva Pennsylvania Furnace Transformer. Even the *promised* shipping period of four weeks had looked like excellent service to the West Coast steelmaker—and by cutting this time by one-fourth, Pennsylvania saved the customer several days of costly downtime for the electric furnace involved. High voltage: 6,600 volts. Low voltage: 450 to 300 volts.

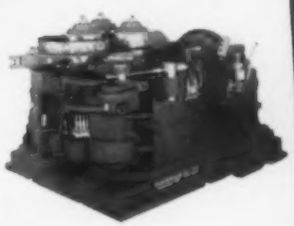
OF COURSE . . . it takes a lot of "everyday" know-how to accomplish the unusual with furnace transformers. Pennsylvania has established a nation-wide reputation for tackling and solving the most difficult problems in this highly demanding field . . . and not-so-incidentally, has designed and built virtually every size and type of furnace transformer now in use: from 250 through 25,000 kva, and from 3175 through 82,000 amperes. To put this furnace transformer experience to work for you, contact Pennsylvania Transformer Division, McGraw-Edison Company, Box 330, Canonsburg, Pa.

PENNSYLVANIA pt PENNSYLVANIA TRANSFORMERS **FURNACE TRANSFORMERS**

McGRAW EDISON

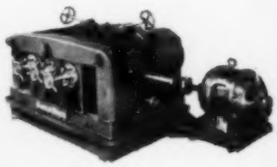


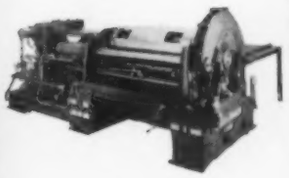




Metal Working Machinery

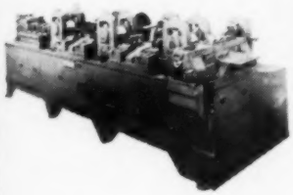
Standard or Custom Built to meet Every Production Demand

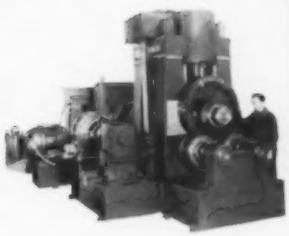




Solving production problems is our business. A letter, wire or phone call will place a qualified engineer at your disposal, quickly and without cost.

Get better production control . . . lower material costs . . . top speed and economy





Straightening Rolls
- Bar and Shape
- Single Plane
- Two Plane
- Sheet Leveler
- Rotary
- Core Wire

Bending Rolls
- Angle
- Pinch
- Hydraulic
- Wrapping

Forming Rolls

Slitters

Edgers

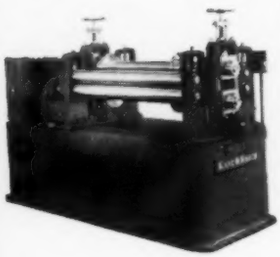
Crimpers

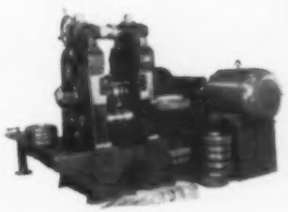
Mills

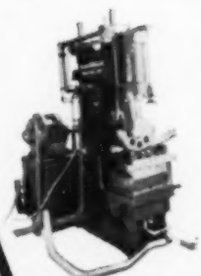
Flying Shears

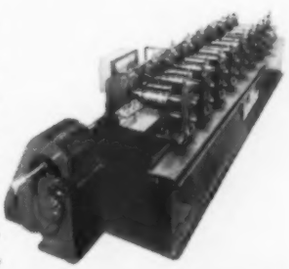
Flying Saws

Special Metal Working Equipment









Represented in all principal cities in United States, Canada and abroad.

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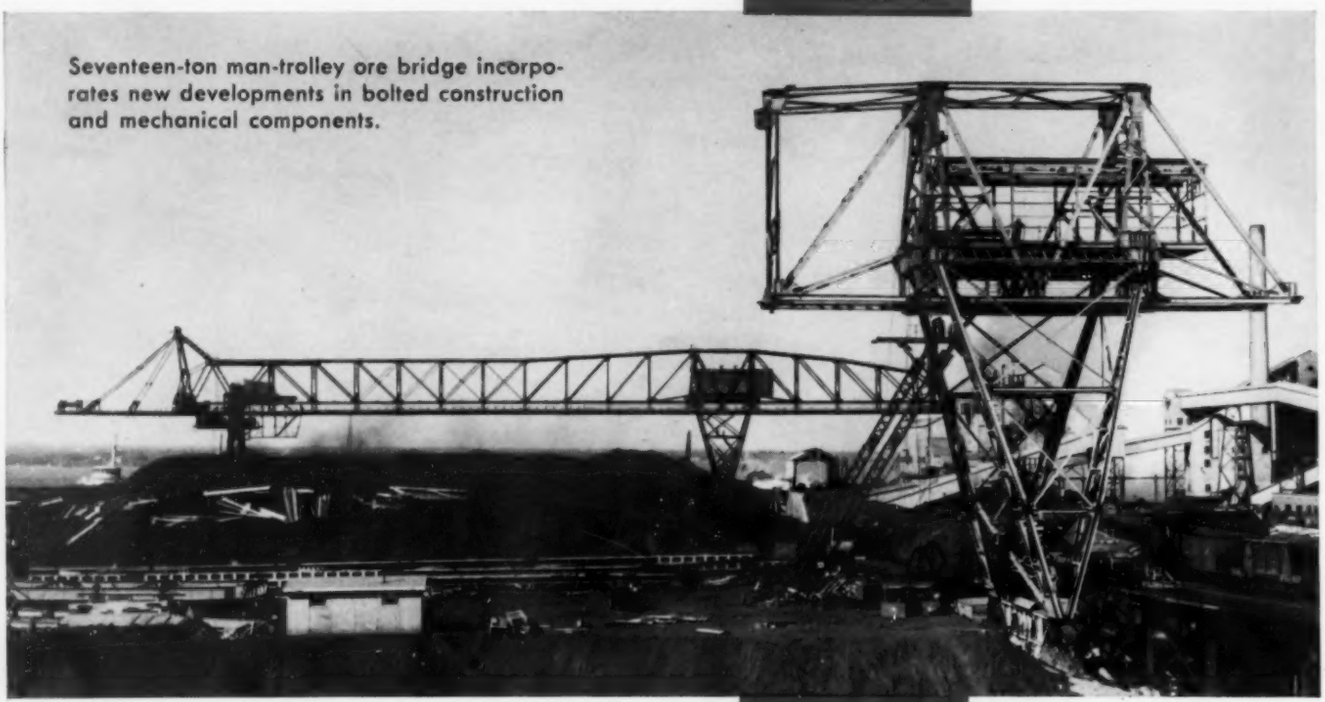
Under Construction . . .

5th Mead-Morrison Ore Bridge

for Major Canadian Steel Producer



Seventeen-ton man-trolley ore bridge incorporates new developments in bolted construction and mechanical components.

This new 17-ton Mead-Morrison direct ship unloading and stocking ore bridge features, in addition to the advanced Mead-Morrison construction that has been proved in the preceding four bridges, a number of exclusive Mead-Morrison developments. These include the use of high tensile steel bolts at all field connections for strength and economy of structural maintenance, extra safe hydraulic rail clamps, new hydraulic buffers, and a new type of man-trolley suspension.

This bridge joins a seventeen-ton bridge completed in 1952, a twelve-ton bridge built in 1942, and two twelve-ton bridges installed in 1931. All these bridges were designed, engineered and built by Mead-Morrison and have given complete satisfaction throughout their life.

If you have material handling problems, you can find your answer by writing to Mead-Morrison.

Mead Morrison

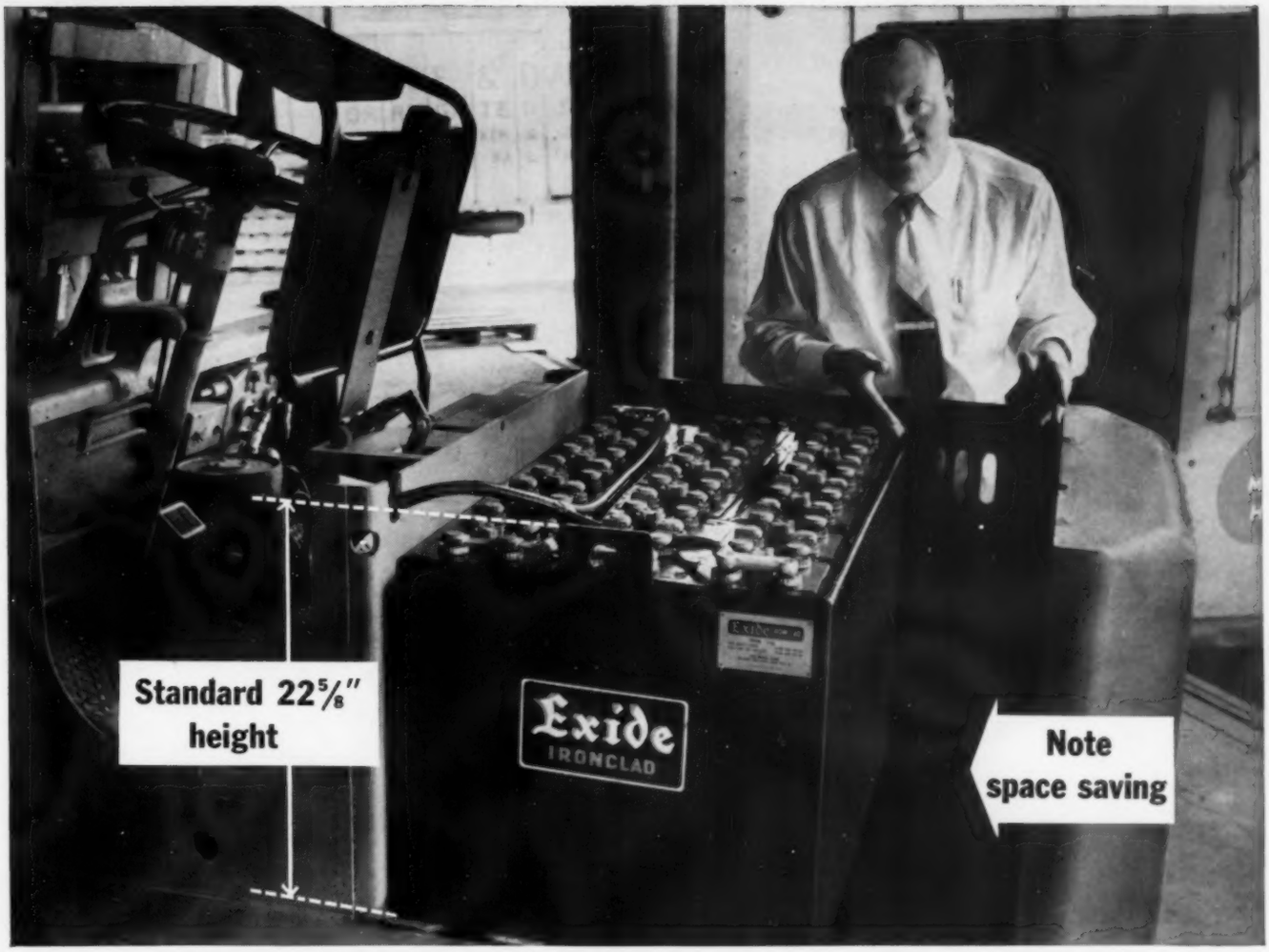
Division of

McKIERNAN-TERRY CORPORATION

Manufacturing Engineers, Harrison, N. J.

Also builders of coal and ore bridges, coal and ore towers, bunkers, pile hammers, and specially designed machinery.

MK-826



Greater flexibility. A 5000 lb. capacity truck with a 648 amp-hr new TG Exide-Ironclad battery. Same truck could hold a 936 amp-hr battery for increased work capacity if needed. Or the 648 amp-hr battery could also be used on a truck as small as 2000 lb. capacity. This flexibility is possible only with Exide's exclusive new TG battery.

NEW TG EXIDE-IRONCLAD BATTERY PACKS SAME POWER IN SMALLER SIZE FOR LOWER COST

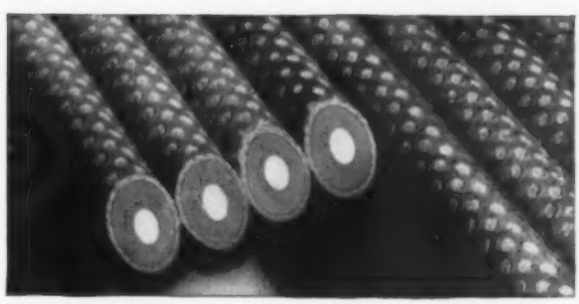
Improved design gives more power and life per dollar. Superior peak-load performance.

Here's the kind of battery economy that really counts: more power and life per dollar. The TG Exide-Ironclad is the most advanced and economical battery ever built for electric industrial trucks.

Every plate packs more power; fewer plates are required to perform a given duty cycle. That means you get a more compact battery with the *standard 22⅝ in. height*. It also means that, for a given capacity, the new TG costs you less. TG's armored porous tubing prevents practically any loss of active material; so even greater economy is gained as a result of its long, dependable service life.

More work from your trucks. The compactness of the TG means you can install more power in your trucks—thus, get more work from them. For a given size truck, TG can give you up to 44% more power than batteries you might otherwise use.

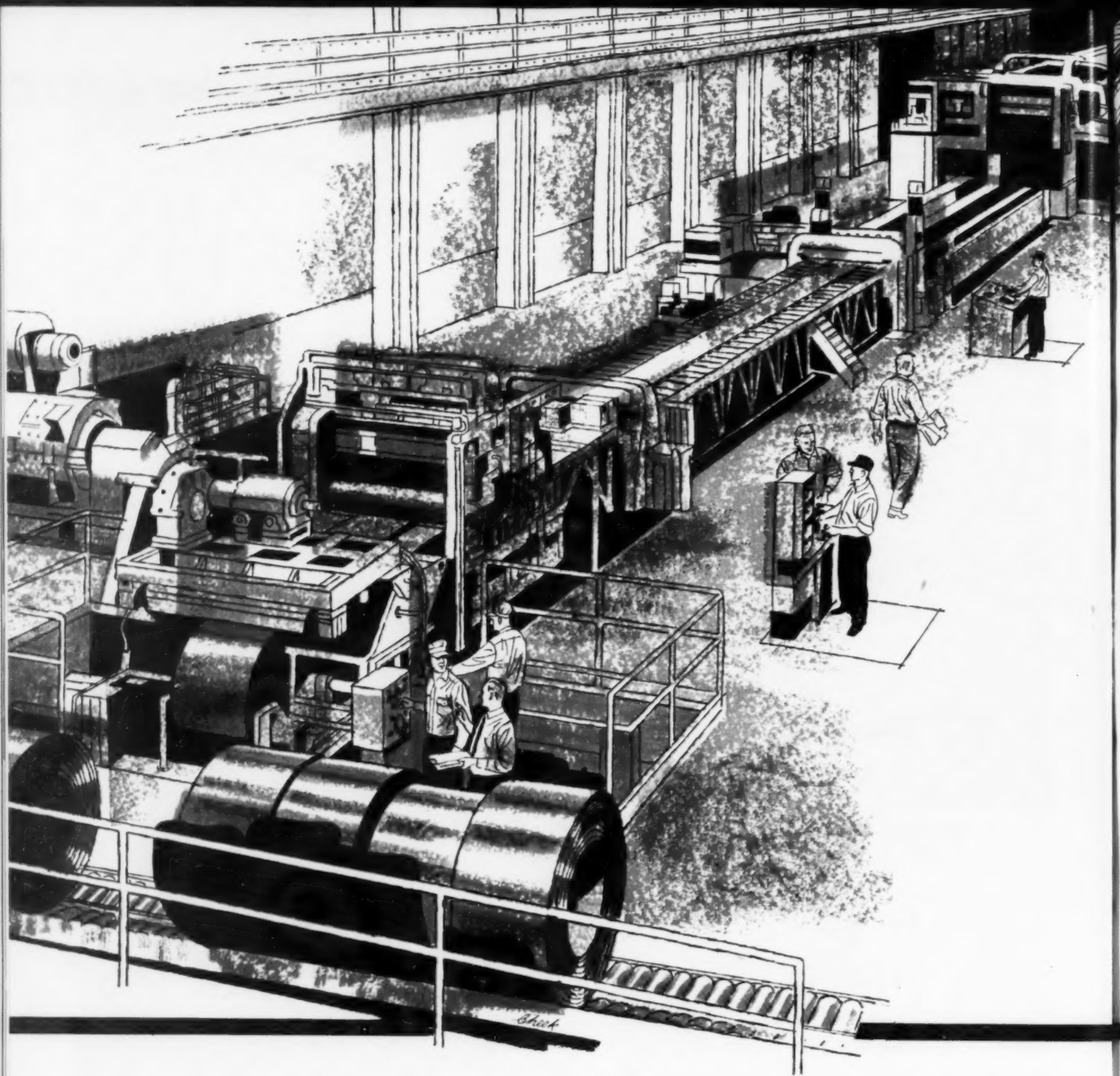
Only Exide offers you so much. When you order new batteries, get all the power, performance and life your dollar can buy. Get TG EXIDE-IRONCLAD. For full particulars about the extra productivity and longer life of the new battery, call your EXIDE Sales Engineer, or write Exide Industrial Division, The Electric Storage Battery Company, Philadelphia 2, Pa.



New, more porous armored tubing for positive plate. Eases current flow. Holds more active material. Boosts battery power. Corrosion resistant Silvium* grid insures long plate life.

*Exide's patented grid alloy

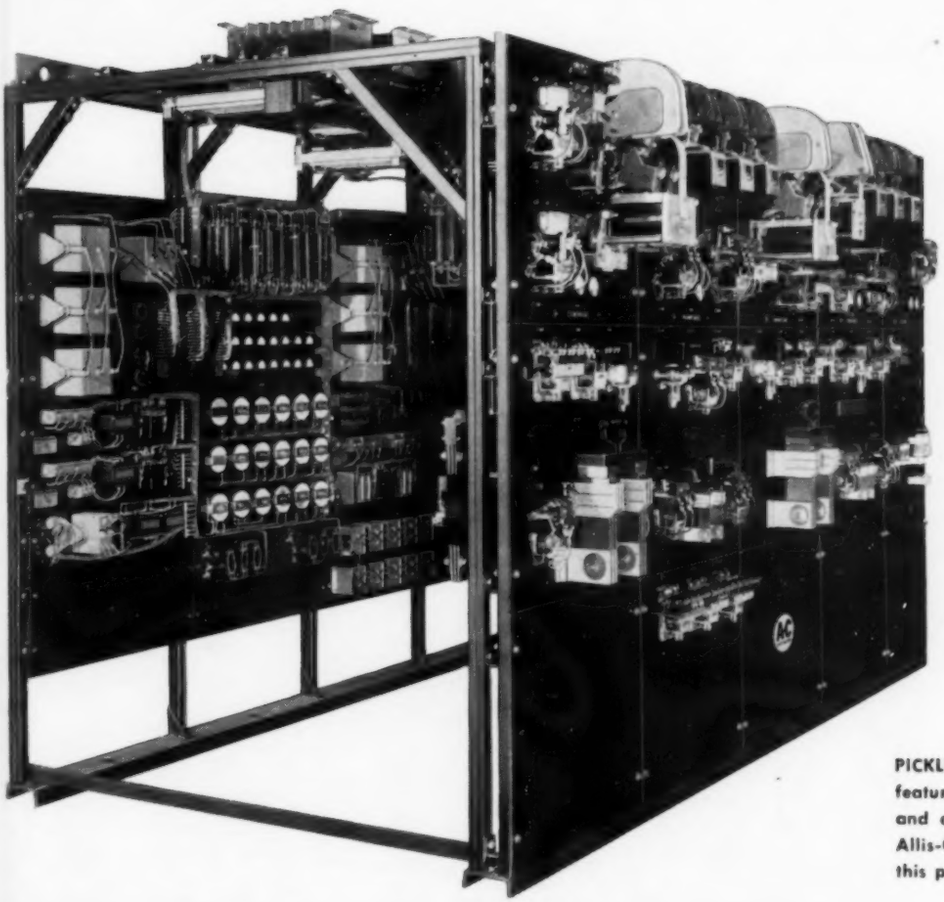
Exide®
THE ELECTRIC STORAGE BATTERY COMPANY



ALLIS-CHALMERS CONTROL...

from furnace to finish

Get ultimate precision control for your pickling line



PICKLING LINE CONTROL, especially designed to the job, features magnetic amplifier regulators for quick response, and complete coordination from entry to delivery section. Allis-Chalmers motors and generators are coordinated with this precision control.

The continuous flow of steelmaking requires step-by-step coordination through the main mill to final process lines. All along the line, Allis-Chalmers control is tailored for each specific operation — yet designed with *your* entire system in mind.

Backed by A-C engineering skill and comprised of quality components, this custom control gives accurate speed and tension regulation from bloom to sheet. It means ultimate control for maximum steel output.

That's why Allis-Chalmers control is gaining more and more acceptance in the mills. Contact your A-C representative or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS

A-C ALLIS-CHALMERS

A-5450

Why GRISCOM-RUSSELL-SCHACK METALLIC RECUPERATORS Perform Better in Iron and Steel Industry Applications

Griscom-Russell-Schack Metallic Recuperators have in 2500 successful installations proved themselves superior over all other metal and ceramic types. Their low original and operating costs coupled with higher fuel savings, make them the first choice of the steel industry. Griscom - Russell - Schack Recuperators have been applied on continuous reheating furnaces, soaking pits, annealing furnaces, rotary kilns, hot blast cupolas, and blast furnaces. Their numerous design advantages have enabled them to provide completely satisfactory service in every case.

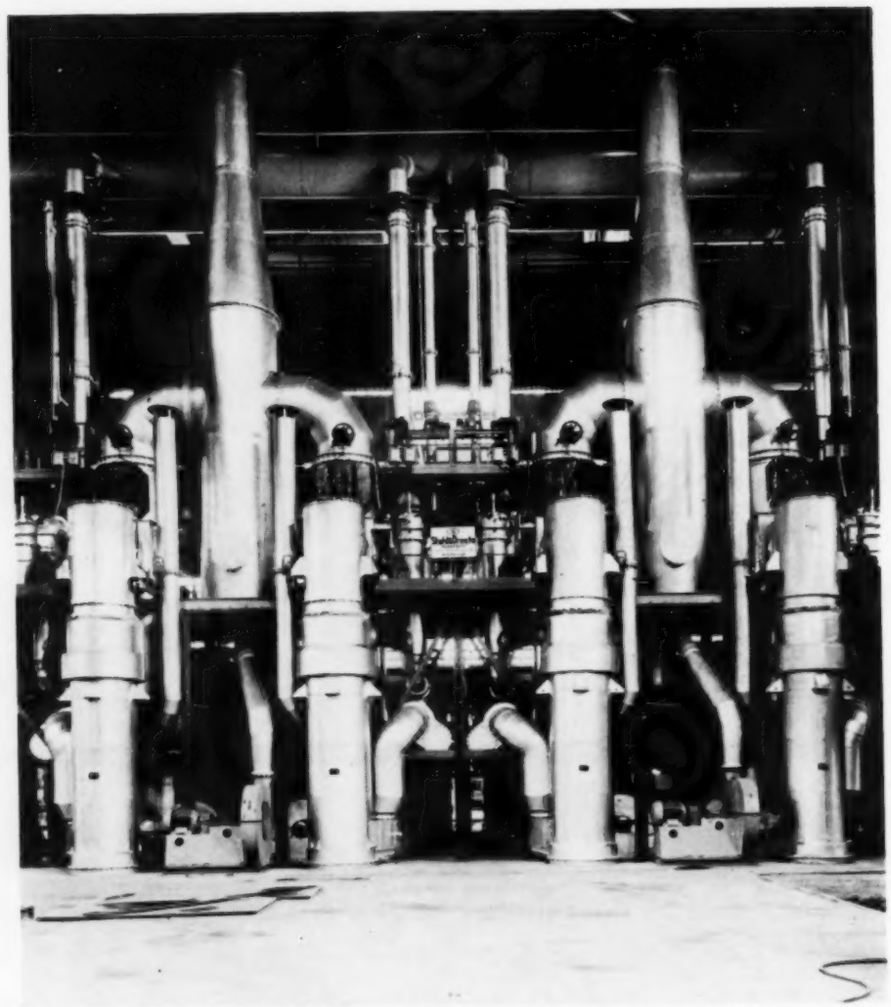
Consider the many important unique features of Griscom-Russell-Schack Recuperators which provide superior performance and reliability even under the most adverse conditions.

Protection against fouling

In conventional types of recuperators, the dirty flue gases flow through a maze of passages around the outside of the tubes. These passages quickly choke up and are difficult to keep clean, resulting in loss of performance and even local overheating and failure of tubes. In the Griscom-Russell-Schack tubular design, the heating gases flow through the *inside* of straight, relatively large-diameter tubes. Therefore, this design is inherently less subject to fouling, especially when the unit is installed vertically.

Protection against overheating

The section of a recuperator most susceptible to overheating is at the point of entry of the hot gases. In the Griscom-Russell-Schack Recuperator, this section is fully protected by special arrangement of baffles and tube sheet at this location, which keeps the temperature of the tubes as close as possible to that of the incoming air or gas to be heated.



Griscom-Russell-Schack Tubular Recuperators in Use in a Major Steel Company Soaking Pit Installation Heating Blast Furnace Gas to 850° F.

Protection against flue radiation

When a metallic recuperator is installed within a flue, it is subject to flue radiation. As a result, the tube wall temperature may become dangerously high if the volume of the air or gas to be heated drops considerably while the flue continues to radiate at a very high temperature, as in the case in soaking pits during the soaking period. In flue-type recuperators, the only safeguard against this condition is to install expensive protection equipment.

The Griscom-Russell-Schack Recuperator is not subject to this danger, because the entire tube bundle is mounted above the *outside* of the flue. Only the first few inches of the tubes are in the path of flue radiation, and that portion of the tubes is protected by a double

Griscom-Russell-Schack Gas-to-Gas Heat Exchangers Feature Preheats up to 1650° F, Entry Temperatures up to 2,500° F with Low Pressure Drop.

tube sheet which is kept cool on the inside by an integral cooling arrangement, supplemented by a substantial layer of refractory on the underside of the sheet.

Protection against expansion strains

The temperature rise in a recuperator naturally causes both longitudinal and radial expansion of the entire unit and some tubes may expand more or less than others. This unequal expansion may be due to uneven distribution of the gas within the tubes accompanying reduction of the volume of gas being heated, or it may be due to uneven collection of dirt or sintering of dirt on the tubes of some designs of recuperators.

In the Griscom-Russell-Schack design, expansion, whether uniform throughout the unit or uneven at different parts, is fully absorbed by the combination of a main shell expansion joint, individual expansion joints on all tubes, floating tube baffles, a non-rigid shell base mounting, and inlet and outlet expansion joints. All expansion stresses and resulting strains are thereby eliminated.

Protection against leakage

The Griscom-Russell-Schack Recuperator is free of packed joints and gaskets to an extent unequalled in any other design. All connections between the tubes and tube sheets are welded. Gaskets are used only at the shell flanges and waste gas take-off, where they must be provided for installation purposes. The resulting gas tightness maintains efficiency by preventing the cold medium from diluting the hot medium, provides greater safety when combustible gases are being heated or cooled, and makes the design ideally adapted for modern high pressure combustion systems.

Protection against high installation expenses

Distinctive features of the Griscom-Russell-Schack Recuperator make installation easier and more economical than in other designs.

a. Counter-current flow in this unit, as contrasted with the cross-flow or parallel flow in other types, results in a more compact installation. It also makes recuperation feasible when otherwise impossible—a particularly important consideration when old installations are being rebuilt and modernized.
b. Suspension of the heating tubes in their own shell eliminates the need of surrounding the tube bundle with a flue which would require costly bricklaying, binding, and supporting steel, and a multiplicity of cold and hot flanges with refractory lining on the latter. Installation only requires placing the unit on a prepared opening in the top of the flue.
c. Range of design permits entry of the hot gases at the base or top of the tubes. Each unit is custom made to suit the application and designed to fit into plant layout.

Protection against high maintenance expense

Additional Griscom-Russell-Schack features save maintenance time and cost:

a. The absence of gaskets eliminates the necessity of periodically repacking joints, tightening up flanges and connections, and replacing gaskets.
b. Tube cleaning, should this ever be necessary, is confined to the *inside* tube surface. The operation is thereby much simplified and involves only brushing out the tubes with conventional tools such as those used on waste heat boilers, and removal of dirt accumulation can be accomplished while the unit is in operation, if necessary.
c. In the infrequent necessity of changing tubes, the welds between tube ends and tube sheets can be ground off externally without touching or defacing the tube sheets in any way, after which the complete tube can be withdrawn with its expansion joints and replaced by a new tube.
d. If the entire unit needs replacing, it may be done with a minimum of downtime. All units have built-in lifting lugs for this purpose. Only three flanged connections need to be disconnected.

Service and Guarantee

Griscom-Russell-Schack provides skilled supervision for installation of its equipment and service during its entire operating life. Service is available through a nation-wide network of engineering sales and service offices in 26 cities. The Company furnishes a performance guarantee based on the customer's specifications, and accepts responsibility for the choice of materials and the workmanship.

Other G-R-S Products

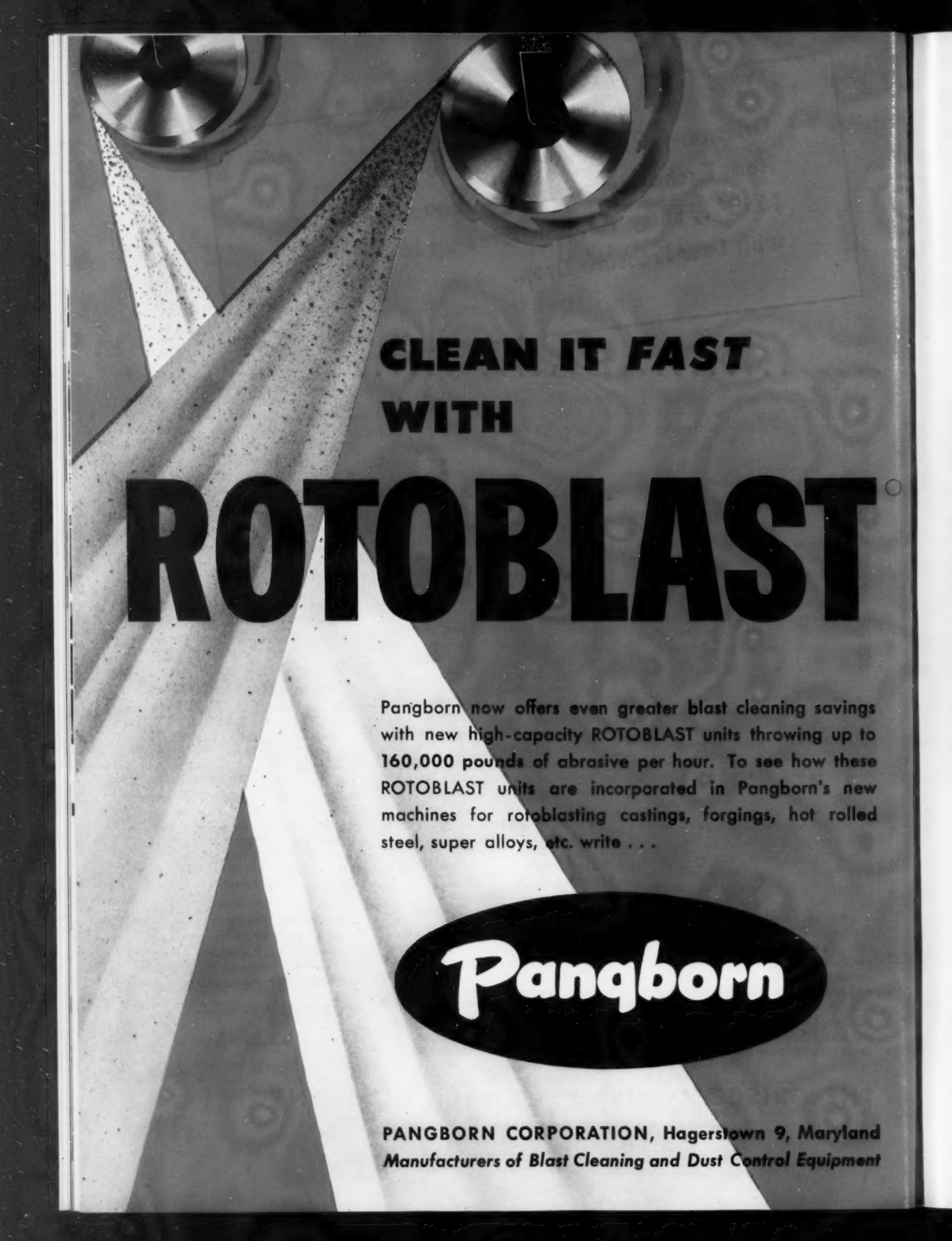
Flue Type Recuperators
Gas-to-Gas Heat Exchangers
Radiation Heat Exchangers
Combination Radiation - Convection Heat Exchangers
Direct-Fired Preheaters for all gaseous media
High Pressure Preheaters

Information on these units will be sent on request.

THE GRISCOM-RUSSELL-SCHACK COMPANY

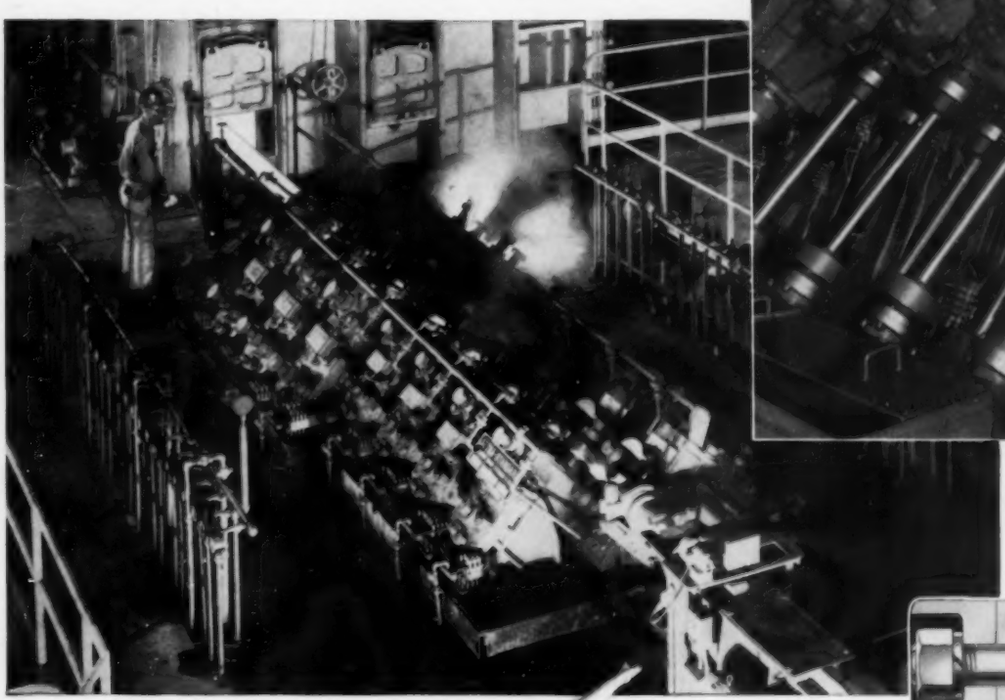
901 RIDGE AVENUE, PITTSBURGH 12, PA.

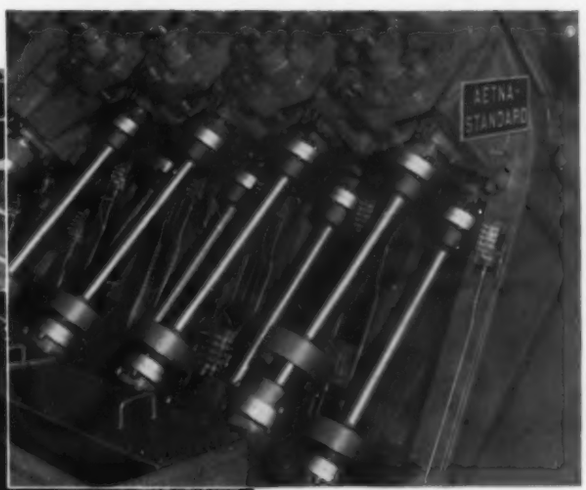
TELEPHONE: FAirfax 1-3986


CLEAN IT FAST
WITH
ROTOBLAST
Pangborn now offers even greater blast cleaning savings with new high-capacity ROTOBLAST units throwing up to 160,000 pounds of abrasive per hour. To see how these ROTOBLAST units are incorporated in Pangborn's new machines for rotoblasting castings, forgings, hot rolled steel, super alloys, etc. write . . .
Pangborn
PANGBORN CORPORATION, Hagerstown 9, Maryland
Manufacturers of Blast Cleaning and Dust Control Equipment

32 AJAX DIHEDRAL COUPLINGS

HELP STRETCH-REDUCE STEEL TUBING





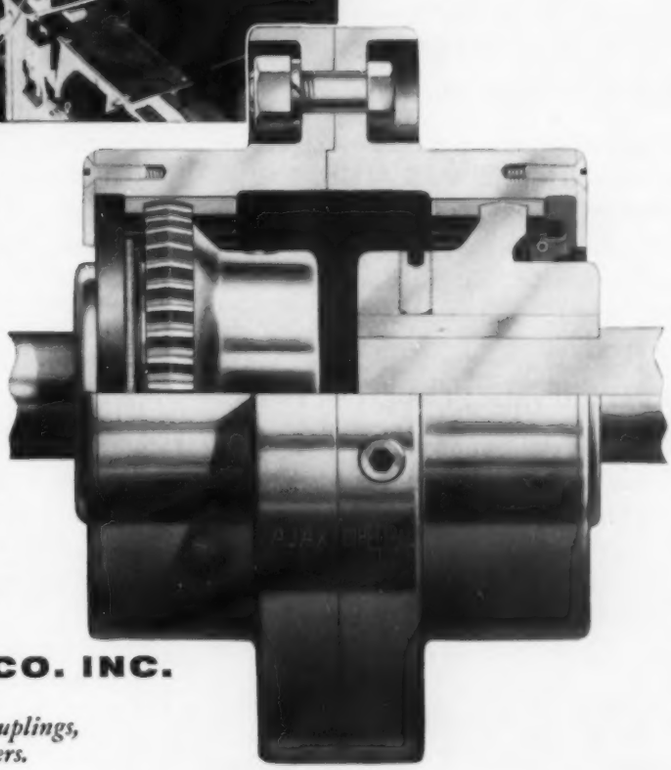
Closeup shows how 32 Ajax Dihedral Floating Shaft Couplings operate at 8°10 min. plus or minus. Note how they are clustered in minimum. space.

Aetna-Standard engineers are taking advantage of the ability of Ajax Dihedral Couplings to operate at the required angle between driving and driven components of this 16 stand stretch reducing mill. This heavy-duty mill reduces approximately 7″ tube down to 2″ tubing.

Constant peripheral velocity of Ajax Dihedral Couplings produces tubing by the mile with diameters and wall thicknesses held to close tolerance.

This is another example of how machinery manufacturers are taking advantage of Ajax Dihedral Couplings to meet exacting design requirements involving angular and offset alignment up to a total of 12 degrees.

Ajax Sales Representatives are qualified by training and experience in field engineering and application problems...it will pay you to get the latest thinking on power transmission with Ajax Dihedral Couplings.



AJAX FLEXIBLE COUPLING CO. INC.

WESTFIELD. N. Y.

Also manufacturers of rubber-bronze cushioned couplings, vibrating conveyors, screens, feeders and packers.

Major Steel Producer Orders Two More Koppers Electrostatic Precipitators for Gas Cleaning

Leading Steelmaker has ordered 15 Koppers Electrostatic Precipitators since 1947

SUCCESSIVE orders over a nine-year period prove the efficiency and economy of Koppers electrostatic precipitators at the plants of one of the nation's top steel producers.

Proves Performance on the Job

This industry leader installed its first Koppers electrostatic precipitator in 1947 at a Pennsylvania plant. Additional orders followed. Koppers units now operate in the company's plants in Maryland and Pennsylvania. Two factors spurred re-orders. Koppers units were economical and efficient. Koppers engineers were able to supply a wide range of CFM capacities.

Supplies a Wide Range

These Koppers electrostatic precipitators range in capacity from 33,334 CFM to 120,000 CFM. Guaranteed efficiency runs as high as 99.2% and each Koppers unit has exceeded its guaranteed performance. Engineering know-how enables Koppers to economically satisfy each individual application.

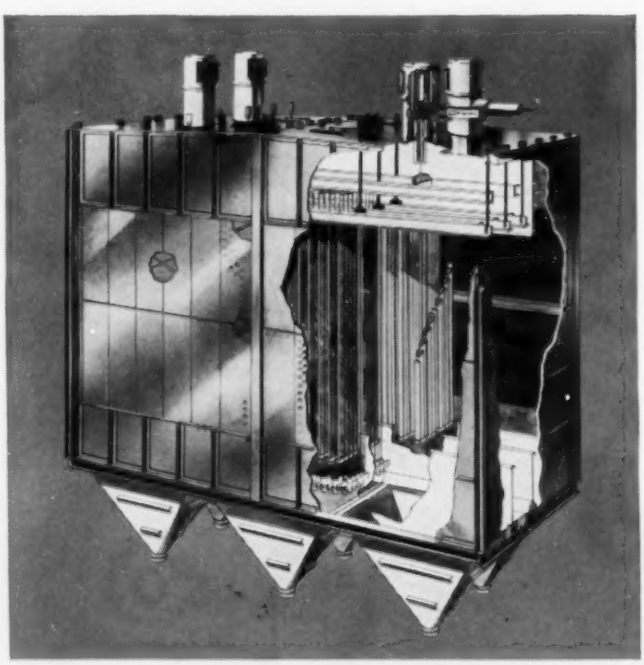
Meets Individual Plant Needs

Koppers custom-designs each electrostatic precipitator for its particular application. It may be at a blast furnace or an open hearth furnace, using either hot or cold metal process. It may be for hot scarfing or detarring coke gases. Whatever the job, Koppers provides highly effective gas cleaning at low cost per foot of gas processed.

Backed by Know-How

Koppers has over 75 years' experience in industrial gas cleaning. In addition, Koppers maintains extensive research facilities at Verona, Pa., and Baltimore, Md. Manufacturing facilities at Baltimore produce a complete line of gas cleaning equipment for every size and type of plant.

You can put all of this experience and equipment to work solving your gas cleaning problem. Just write KOPPERS COMPANY, INC., Metal Products Division, Industrial Gas Cleaning Dept., 8309 Scott Street, Baltimore 3, Maryland.



Cutaway photo of a Koppers electrostatic precipitator shows shell, vibrators, and collecting and discharge electrodes. The actual design and arrangement of elements vary widely because Koppers electrostatic precipitators are custom-designed to fit the requirements of each particular application.

Personnel News...

Nicholas P. Veeder executive vice president of the Granite City Steel Co., was elected president at a meeting of the board of directors, August 8. He was also elected a member of the executive committee. Mr. Veeder, who has been with Granite City since 1934 and executive vice president since May, 1956, succeeds **Geo. B. Schierberg,** president and treasurer, who retired September 1 under the company's mandatory retirement plan. Mr. Schierberg will remain as a member of the company's board of directors and executive committee, will be chairman of the newly-formed finance committee and will also serve Granite City as a consultant. **John N. Marshall** remains as chairman of the board and chief executive officer. Mr. Veeder has been in the steel business since 1933, and with Granite City since 1934 when he became an analyst in the company's chemical laboratory. He became, successively, assistant to the director of the company's department of metallurgy and inspection, assistant superintendent of the company, production manager in charge of organizing an industrial engineering department to take care of job classifications and of supervising production scheduling for the mill, and works manager. In 1949, he was elected to the newly-created position of vice president in charge of operations. He became a director of the company in 1953, and executive vice president in 1956.

R. W. Couch, formerly superintendent of structural mills and shipping yard at Bethlehem Steel Co., Bethlehem, Pa., was appointed assistant superintendent of the Saucon Div. succeeding the late **J. R. Chegwidden.** At the same time, **J. F. Connors, Jr.** was appointed assistant to superintendent of Saucon Div. He was formerly assistant superintendent of structural mills and shipping yard. **E. S. Olmsted,** formerly superintendent of shape mills was named superintendent of structural mills and shipping yard. Other appointments announced were: **L. R. Pennauchi** assistant superintendent of structural mills and shipping yard; **P. F. McHale,** as superintendent of shape mills and soaking pits; **W. T. Middleton** as superintendent of structural shipping yards; **M. B. Deysher,** as assistant superintendent of shape mills and soaking pits; and **B. Ewing** assistant superintendent of structural shipping yards.

Dr. Oscar T. Marzke has been appointed vice president—fundamental research of United States Steel Corp. Dr. Marzke was formerly director of research, U. S. Naval Research Laboratory, and was previously associated with U. S. Steel in the research department of American Steel and Wire Division. His first employment with U. S. Steel was as assistant director of American Steel and Wire's research laboratory in Worcester, Mass., in 1934. He was made assistant district metallurgist in Worcester in 1938 and works metallurgist of North Works in 1940. He was transferred as works metallurgist to Waukegan Works in 1942. Joining Navy research in 1946, Dr. Marzke was made superintendent, metallurgy division of the U. S. Naval Research Laboratory. He was made associate director of research in 1954 and director of research in 1956.

W. V. Dovenbarger, former general foreman of annealing and sheet welding at the Zanesville, Ohio, Works of Armco Steel Corp., has been appointed superintendent of the Works' Processing Department.

George M. Humphrey, former secretary of the Treasury, returned to National Steel Corp. with his election as chairman of the board of directors at a board meeting August 14. Mr. Humphrey was one of the founders of National Steel Corp. He became a member of the board and chairman of the executive committee when National Steel was organized in late 1929 and continued in these capacities until he became a member of President Eisenhower's Cabinet in 1953.

Admiral Ben Moreell, chairman of the board of directors of Jones & Laughlin Steel Corp. announced that, on his recommendation, the board elected **Avery C. Adams** to be chief executive officer of the Corp. as of October 1, 1957. Mr. Adams is now president and chief operating officer. Admiral Moreell will retain the functions of chairman of the board of directors and chairman of the executive committee.

Clemens A. Tarter was named assistant superintendent of the tin mill at Kaiser Steel Corp. Mr. Tarter came to Kaiser in 1954 to head the cold reduction department in the tin mill. He had previously served with Republic Steel Corp. for 20 years. At the same time,

N. P. VEEDER

R. W. COUCH

DR. O. T. MARZKE

W. V. DOVENBARGER

C. A. TARTER

A. G. TROTT

P. E. NELSON

R. W. FRANK

A. G. Trott was appointed assistant superintendent in charge of the hot dip and finishing departments of the tin mill. Mr. Trott, who came from Wheeling Steel Corp., joined Kaiser in 1952 as general foreman of the electro tinning line. In 1955 he became general foreman of the tin mill electrolytic division. Also, **Paul E. Nelson** was named assistant superintendent of the cold reduction department of the tin mill, and **Ralph W. Bush** was named general foreman of cold reduction. Mr. Nelson came to Kaiser in 1948, starting in the galvanizing department of the continuous weld pipe mill, advancing to the position of shift foreman in pipe heating and forming. Upon completion of the tin mill in 1951, he was named general foreman, annealing and cleaning, and held that position to the present time. He previously served with Carnegie-Illinois and Lee Wilson Engineering Co. Mr. Bush started as a production assistant at Kaiser Steel in 1952. A year later he was appointed foreman assistant in the tin mill, then was named shift foreman of the cleaning and annealing department. Prior to his new position he was employed as a practice assistant in the tin mill.

Robert W. Frank has been elected vice president of Birdsboro Steel Foundry & Machine Co. Mr. Frank was formerly vice president—mill machinery sales, of the Blaw-Knox Co. He previously served in various capacities with the Duquesne Works of U. S. Steel Corp. during the early part of his career. He was superintendent of the blooming and billet mills there from 1940 to 1945.

C. Vincent Sciullo was appointed assistant manager of the Cold Heading Machinery Division, Waterbury Farrel Foundry & Machine Co. Mr. Sciullo returns to the company's home office from Cleveland, Ohio where he has been manager of the Cleveland sales office since early 1956. He has been with the company since 1936.

Stanley M. Norwood has been appointed assistant to the president of Electro Metallurgical Co. In addition to his new responsibilities, Mr. Norwood will continue as vice president of this division of Union Carbide Corp. Mr. Norwood has been associated with Union Carbide since its formation in 1917, and since 1927 has devoted his time to sales and technical development with Electro Metallurgical Co.

William Robert Doreen has joined A. M. Byers Co. as a field service engineer. He will work out of the company's Houston office. Mr. Doreen previously held similar positions with Republic Steel Corp. and Mid-West Materials, Inc.

Patrick V. Gallagher was appointed vice president of McDowell Co., Inc., Dwight-Lloyd Division. Mr. Gallagher joined Dwight-Lloyd in 1955, as chief engineer. Previously, since 1950, he had been assistant chief engineer of M. H. Treadwell Co.

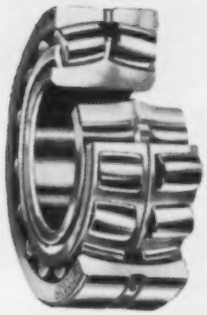
P. V. GALLAGHER

Myron R. Bowerman, director of research for the Alliance Machine Co. was elected as a Fellow of the American Society of Mechanical Engineers.

Alexander S. Basil has been named works manager of Rockbestos Products Corp. He joins Rockbestos after thirty years with the United States Rubber Co. where he held several executive positions.

Basil T. Lanphier, formerly metallurgist for stainless and high temperature alloys, has been named manager

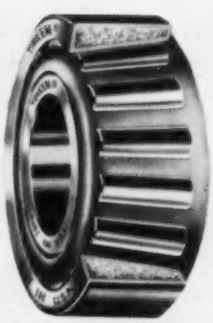
16,846 V.I.C.s



An analysis just completed revealed that 16,846 firms in the Chicagoland industrial area order bearings, bearing specialties, and transmission appliances from Berry Bearing Company.

Many of these customers are small, others are medium in size, and a surprising number are the largest of their kind in the world. Some order occasionally, others frequently, and still others place orders regularly, week after week.

Because Berry Bearing is growing, many of these customers are comparatively new. But, a large number have been on the company books for 5 to 10 years. And, a significant percentage--including one of the world's largest steel producers...a huge oil refinery...an internationally known meat packer...and...many others--have been ordering from Berry for 30 to 35 years!



Regardless of size or volume--every one of these 16,846 firms is a Very Important Customer to Berry Bearing...and...each gets maximum service on every order. So, when you order bearings, bearing specialties, or transmission appliances from Berry--you automatically become a V.I.C. And as a V.I.C. you'll get maximum service...and...immediate delivery on every order.

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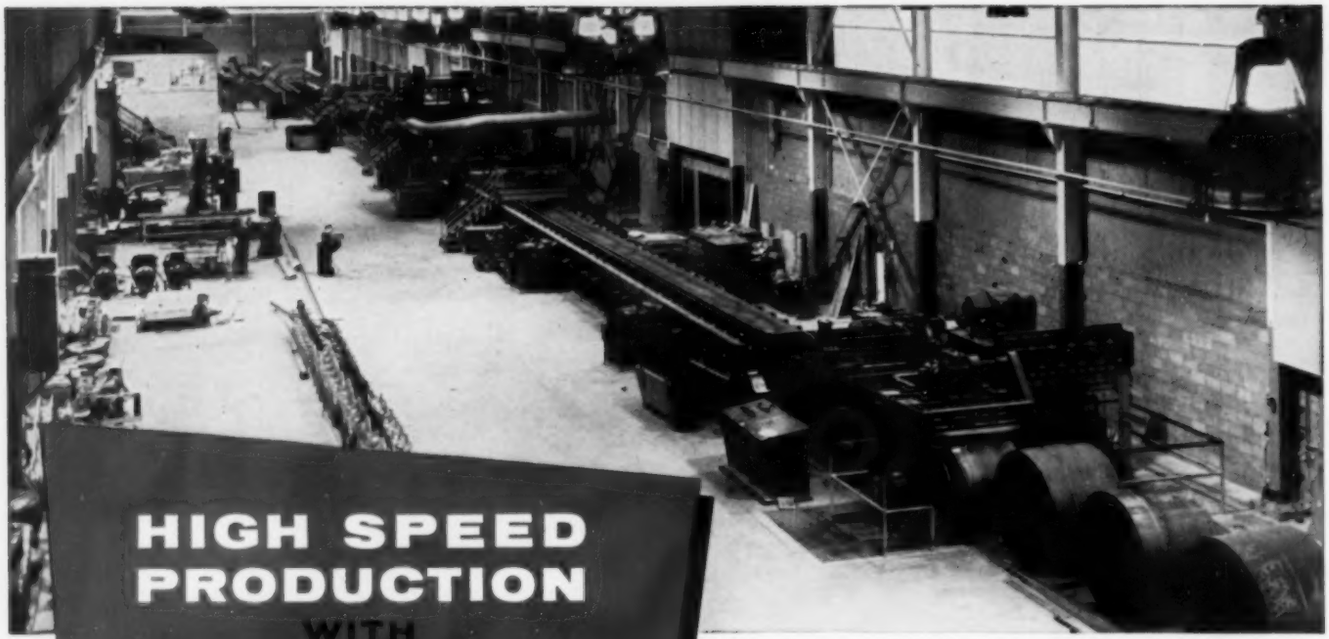


HIGH SPEED PRODUCTION WITH RELIANCE V★S DRIVES

Six Reliance V★S Drives make it possible to operate this complete line as if it were a single machine.

Carloads of pipe are pouring out of the new Edmonton, Alberta plant of Alberta Phoenix Tube & Pipe, Ltd. This $6.5 million installation is producing pipe at unprecedented rates.

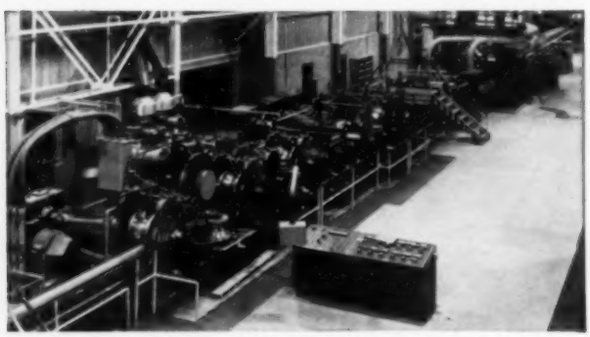
Volume pipe production requires something special in a drive system—one that furnishes precise speed control and instantaneous motor response. A wide stepless range of speeds is provided to handle various pipe diameters and lengths, and all sections of the line operate at the same relative speed.

A team of Reliance Application Engineers, working with the machinery builder, built this specialized drive. This team knows the processes of the steel industry and how to handle the problems involved. Engineering knowledge, backed by the quality of Reliance products, supplied this accurate, simple-to-operate, economical drive.

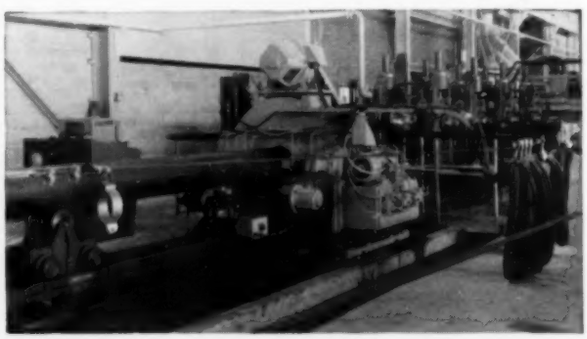
The Reliance Application Engineering Department builds drives for every industry. A team of engineers who are experts on your industry's operation, stand ready to engineer and build the drive for your particular needs.

If you would like more information on this installation, write for Bulletin L-2505.

L-1541



The welding section operator controls the speed of the entire line from this Reliance Pendent Station.



The Reliance V★S Drive on this flying cutoff automatically measures the pipe and controls the movement and speed of the carriage.

RELIANCE ELECTRIC AND ENGINEERING CO.

DEPT. 119A, CLEVELAND 17, OHIO · CANDIAN DIVISION: WELLAND, ONTARIO

Sales Offices and Distributors in Principal Cities

of research, Carpenter Steel Co. Also, **Howard O. Beaver,** formerly plant metallurgist-melting, has been promoted to production metallurgist in charge of melting and hot working.

Karl Koehn was named assistant vice president of sales of Commercial Contracting Corp. Mr. Koehn joined Commercial Contracting in 1952 as superintendent of erection, in charge of the installation of facilities at Pittsburgh Steel Co's plant at Allenport, Pa. A year later he was named sales engineer, and has been closely identified with the steel industry. Since coming to the United States in 1922 from Germany, Mr. Koehn has been associated with Mesta Machine Co., Taylor & Wilson and Pittsburgh Engineering & Machine Co.

Philip H. Dreissigacker has been appointed sales manager, Farrel-Birmingham Co., Inc. in charge of sales and engineering of the following products: rolls, roll grinders, industrial and marine gears, special machinery and castings. Mr. Dreissigacker has been with Farrel-Birmingham since 1937. He has served as assistant chief engineer since 1954.

A. E. Somerville was appointed manager of all construction operations of Arthur G. McKee & Co. Mr. Somerville succeeds the late **James H. Sharpe** with whom he had worked as assistant construction manager for the past few years. He has served with McKee since 1940 as assistant construction superintendent, construction superintendent, general superintendent of construction for Metals Division projects and assistant construction manager. **R. G. Widman,** construction superintendent for McKee, has been named assistant construction manager. He joined the McKee Co. as a field engineer in 1948, and was promoted to construction superintendent three years later.

H. J. Campbell was appointed Kansas City district manager for Elliott Co. He joined Elliott in 1943, and was originally assigned to the company's Chicago district office. He has been in the Kansas City office since 1948.

Roy D. Allen was named chief metallurgist at Republic Steel Corp., South Chicago District. Mr. Allen, who has been assistant chief metallurgist at the company's South Chicago operations since 1942, succeeds **Andrew G. Forrest,** who recently was named assistant to the chief metallurgist in Republic's Cleveland general offices.

Paul Jordan, plant engineer at the Dodge Manufacturing Corp. since 1943, has been appointed director of engineering. He has been with Dodge since 1935, and served as a member of the engineering department before becoming plant engineer.

Charles A. Mueller has been named chief engineer of the new Gas Process Division of Lindberg Engineering Co. Mr. Mueller returns to his former company after several years in engineering and metallurgical work in Utah and Calif.

Dr. Robert W. Lindsay, Professor of Metallurgy at The Pennsylvania State University, has joined the staff of the Crucible Steel Co. of America's Central Research Laboratory in Pittsburgh. Dr. Lindsay, who has been on the Penn State faculty since 1943, will assume the position of supervisor of constructional alloy steels at Crucible's research center.

W. Ward Powell, vice president, Mesta Machine Co. was awarded the Italian decoration "Commenda al Merito della Republica," in recognition of his contributions in the field of Italian-American relations. The formal document was signed by the president of the Republic of Italy and the foreign minister. In making the presentation, the consul general of Italy declared, "With his great experience and knowledge, he has aided the creation of huge steel plants which today are among the most modern in Europe."

John J. Boyle, Jr., has been appointed exclusive sales and service representative in the Columbus, Ohio area by Lewis-Shepard Products, Inc. Mr. Boyle was previously assistant to the vice president and general sales manager at Lewis-Shepard's general offices in Watertown, Mass.

Morton M. Jenkins has joined A. M. Byers Co. as steel sales metallurgist. Mr. Jenkins was formerly chief metallurgist with Pittsburgh Forgings Co. and has also

KARL KOEHN

P. H. DREISSIGACKER

A. E. SOMERVILLE

R. G. WIDMAN

N. T. SHIDELER

A. E. GRAY

J. P. KELLY

ELLISON WEFEL

been associated with United States Steel Corp. and Republic Steel Corp.

Norman T. Shideler was elected president of Insul-Mastic, Inc., a newly acquired subsidiary of Pittsburgh Coke & Chemical Co., while **Arthur E. Gray** was named to succeed Mr. Shideler as general manager of the Protective Coatings Division. Mr. Shideler will also act as technical adviser to the vice president—Chemical Divisions with regard to all industrial protective coatings and tar products of Pittsburgh Coke.

John P. Kelly has been appointed general sales manager of the Industrial Division of Gould-National Batteries, Inc. Mr. Kelly had previously served as Detroit regional manager and will now make his headquarters at Trenton, N. J. Mr. Kelly's promotion follows 12 years of experience in the industrial battery field with Gould in the Philadelphia and Detroit areas.

Ellison Wefel has been appointed chief engineer of the Anker-Holth Division of Wellman Engineering Co. Mr. Wefel comes from the Lombard Corp. where he was a vice president.

J. E. Brinckerhoff, vice president of The Babcock & Wilcox Co., has been elected president of The Refractories Institute. Mr. Brinckerhoff has been a director of the organization since its inception in 1951.

George E. Drake has been appointed vice president in charge of sales of Electro Metallurgical Co., Division of Union Carbide Corp. Prior to his new appointment, Mr. Drake was assistant general manager of the Silicones Division of Union Carbide Corp. He joined Union Carbide in 1930 as a salesman for the Linde Co.

Paul Terrien has been promoted from customer service representative at the Niagara Falls, N.Y. plant of the Electrode Division, Great Lakes Carbon Corp. to sales representative at the Division's Pittsburgh office. Mr. Terrien started as a process engineer with the Electrode Division at Niagara Falls in 1955.

Roger J. Schumacher, formerly a sales engineer at Pennsylvania Transformer Division, McGraw-Edison Co.'s headquarters in Canonsburg, Pa., will be in charge of the firm's newly-opened sales office in Buffalo, N. Y. Before joining Pennsylvania Transformer in 1954, Mr. Schumacher was a sales engineer for Baldwin-Lima-Hamilton Corp.

C. E. Ford has been named to the newly-created position of new products marketing manager by National Carbon Co., Division of Union Carbide Corp. He joined National Carbon in 1937 after working for an engineering consulting firm. Following several assignments in the industrial sales department, Mr. Ford was named manager of chemical products sales in 1953, from which position he comes to his new assignment.

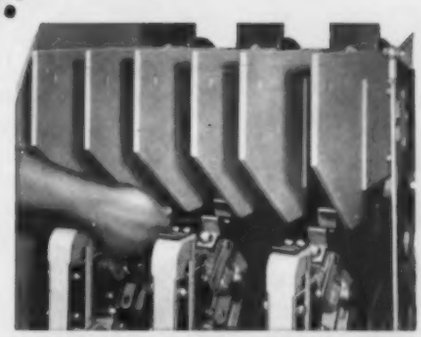
C. E. FORD

John L. VanNort, formerly manager of application engineering was named regional sales manager for the Midwest region of Reliance Electric & Engineering Co. He is succeeded by **Robert O. Gee** whose former position as manager of service is taken by **George E. Law. William C. McConnell** moves up from manager of standard products in the marketing division to manager of general products. **Anthony P. DiVincenzo** was appointed manager of control engineering and **John J. Dailey, Jr.** manager of control manufacturing at the plant in Euclid, Ohio.

Here is **DESIGN LEADERSHIP** *...in Action!*

Save Space with New EC&M High Voltage (2200-4800 VOLTS) Starters

only 30" deep!



NO DRAW-OUT NEEDED • Arc shields slide out horizontally, making front and rear contact-tips removable with standard wrench.

Accessible from Front...

(Solid back) • Starters may be mounted against wall or in double row, back to back

Safe...

Starter DISCONNECTED from bus as door is opened
Low voltage section isolated from high voltage

Interlocked...

against accidental closure by simple rod mechanism
Large wiring space for incoming leads

EC&M's new ZHA Starter not only saves valuable floor space—it provides more accessibility and convenience than ever before. Starters are available with self-contained bus in isolated compartment. A gang of starters requires only one incoming feeder. Additional starters can be added as needed—with no sacrifice in neat, streamlined appearance. All starters are self-contained and complete with control transformer supplying low voltage for pushbutton circuits.

***Write for* BULLETIN 8130-F**

3 Interrupting Ratings for Squirrel Cage, Synchronous and Wound-rotor Motors

1. **CLASS E 1** • 50,000 KVA (symmetrical) based on certified tests.
2. **CLASS E 2** • With current limiting fuses and high interrupting capacity contactor. At 2300 volts: 150,000 KVA, 3 phase; 60,000 RMS amperes asymmetrical. At 4,800 volts: 250,000 KVA, 3 phase; 60,000 RMS amperes asymmetrical.
3. **VALIMITOR®** • May be used on a bus of unlimited short circuit capacity, through the use of a contactor with an interrupting rating of 50,000 KVA, and reactors which limit any fault current to a maximum of 25,000 KVA.

THE ELECTRIC CONTROLLER & MFG. CO.
A DIVISION OF THE SQUARE D COMPANY
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7955

Any similarity to a real-life company is purely intentional

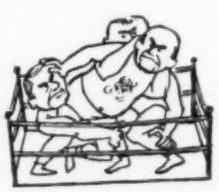
How does the master mechanic avoid tons of trouble?

When Flint N. Steele got his first job, he was determined to set the world afire. He had lots of spark — went on to big things. Today, he's one of the mighty over at Mighty Metals — master mechanic, to be exact.

MM rolls heavy tonnage in the course of a year. You never catch *them* with their plants down! And you never will, if Flint Steele has his way.

"No peanut-brittle part failure is going to foul up our production schedules!" is the way he puts it. Or words to that effect.

Now if you've ever seen a high-speed, continuous rolling mill, you know that it develops more impact, leverage, and load than a ringful of wrestlers. Several million instantaneous inch-pounds is nothing! (That's nothing?) Guarding against costly downtime is a mighty weighty problem indeed.



One way that Flint does it is by insisting on Ampco Metal at all critical points; for instance: (1) in the screw-down nuts; (2) in the screw-down worm wheel; (3) in the slippers (universal-joint bearing segments); (4) in the breaker blocks.

Ampco Metal is a uniform-quality copper-base alloy of such special yet sound structure that it withstands severe pressures and shock—and the abrasive action of powdered scale. It resists corrosion, so avoids the extra expense of special lubrication.

These characteristics make Ampco Metal especially suitable for use also in wearplates, pickling operations, and other production applications.

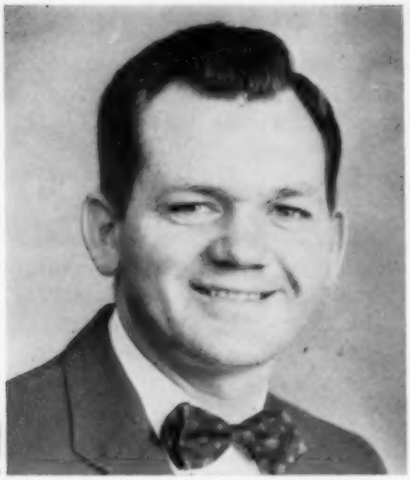
Where can Ampco save money for *you?* Talk it over with your nearby Ampco field engineer. And write for Bulletin 33 today. *Ampco Metal, Inc., Dept. IS-9, Milwaukee 46, Wisconsin (West Coast Plant: Burbank, Calif.)*

AMPCO® METAL

The metal without an equal

6-3

FRANK MOSKO



W. R. STOUT

J. R. PERKINS

J. W. BAUER, JR.

Frank Mosko has been appointed sales manager of the David W. Murray Co. Mr. Mosko was formerly assistant to the first vice president, Aetna-Standard Engineering Co. Previously, he was assistant to the chief engineer at Aetna-Standard.

Worley R. Stout has joined the Pittsburgh district office sales staff of the Clark Controller Co. He was previously with Clark at its main office in Cleveland.

John R. Perkins has been appointed to the newly-created post of assistant to the present in charge of market development for McDowell Co., Inc. Mr. Perkins worked for General Electric Co., first in engineering and then in sales, from 1937 until 1940. Since then, until joining McDowell, he has been with Delco Products Division of General Motors Corp.

John W. Bauer, Jr. has been named to the newly established post of sales manager, Femco, Inc. For the past year, Mr. Bauer has acted as district sales manager in the western Pa. area. Previously, he served the firm as a sales engineer for eight years.

Dr. John H. Hoke was appointed supervisor of the Stainless Steel Section of the Central Research Laboratory, Crucible Steel Co. of America. Dr. Hoke joins Crucible from Babcock and Wilcox Co., where he had served three years as a research metallurgist at the company's research center in Alliance, Ohio. Beginning his career as a laboratory assistant at the Pennsylvania State University in 1946, Dr. Hoke joined Armco Steel Corp., Baltimore, Md., as a research assistant in 1947. He was employed by Johns Hopkins University as an instructor from 1950 to 1954, when he joined Babcock and Wilcox.

W. D. MacDonnell was recently appointed vice president in charge of operations of the Great Lake Steel Corp., a division of the National Steel Corp., Detroit, Mich. Mr. MacDonnell was formerly assistant to executive vice president of the National Steel Corp.

Richmond P. Hobson was appointed works manager for the new stainless steel plant to be built at Coshocton, Ohio, by The Universal-Cyclops Steel Corp.

Mr. Hobson will direct and be responsible for the planning, engineering, and staffing of the Coshocton plant. He has been with the company for 16 years and prior to his new appointment, was manager of the bar, wire and strip mills at the Bridgeville plant.

John L. Thoman has been promoted to Division Industrial Engineer in Jones & Laughlin Steel Corp.'s Stainless Steel Division at Warren, Mich. Mr. Thoman formerly was assistant supervisor—planning and opera-

1—34" REVERSING HOT STRIP MILL CONSISTING OF:

1—Slab re-heating furnace 44" wide x 93'4" long, 4 heating zones, oil and gas burners.

1—Mill drive motor, reversing, 2500 HP, 75/150 RPM, 600 volt D.C., with controls.

1—28" x 40" 2-high reversing mill having Morgoil bearings in roll stand, Timken bearings in pinion stand, universal spindles with carriers, 75 HP motor screwdown.

2—Re-heating coiling furnaces, each 50" wide, for gas or oil fuel, for coiling and uncoiling strip under tension while being rolled to thinner gauges.

1—Delivery table, 38" wide x 136'6" long, with anti-friction bearings. Speed 900 FPM.

1—Coiler 24" dia. driven by 100 HP, 485/1200 RPM motor. Timken bearings. Air push-off.

1—Coil discharge gravity conveyor 70'4" long.

1—Main motor-generator set for supplying reversing motor; also auxiliary generators.

All of the above equipment is in good operating condition, has been used very little. Further details will be furnished upon request.

FRANK B. FOSTER, INC.

2220 Oliver Building, Pittsburgh 22, Pa.
cable: "Foster, Pittsburgh" Telephone ATlantic 1-2780

tions analysis in the Industrial Engineering Department at J&L's Pittsburgh Works. He joined J&L in 1950 as a practice engineer in the Electrical Maintenance Department at J&L's Pittsburgh Works. He was transferred to the Industrial Engineering Department in 1952 and was named group leader, methods and standards Division, in 1954. He was promoted to assistant supervisor—planning and operations analysis in 1955.

Chester A. Sellen, who joined the Reliance Division of Eaton Manufacturing Co. as chief metallurgist 18 years ago, has been named general manager of this division. His promotion came simultaneously with the announcement of the retirement of **E. D. Cowlin,** general manager of Reliance, after 33 years of continuous service. Mr. Sellen has been assistant general manager and chief metallurgist of the Reliance Division since August, 1954. Prior to joining Eaton he was associated with the Republic Steel Corp. for 10 years.

David C. Fulton has been appointed manager of the heat transfer apparatus department for the steam division of the Westinghouse Electric Corp. Mr. Fulton was manager of the marine section steam sales department since January 1955, from which position he comes to his new assignment.

William Mohr has been appointed works manager of the Pacific Coast Division of the Colorado Fuel and Iron Corp. Up to the time of his appointment Mr. Mohr was wire mill superintendent. Prior to that he had been a master mechanic at the plant. Mr. Mohr joined C F & I in 1935.

Charles W. Iams has been appointed an assistant vice president, industrial engineering of United States Steel Corp. He began his employment with U. S. Steel in 1933 as a metallurgical observer at Homestead Works. He was made assistant plant industrial engineer in 1935 and plant industrial engineer at Clairton Works in 1936. Mr. Iams was transferred to the Pittsburgh general office in 1939 on special assignment. In 1948 he left the corporation to become an operating executive with Firth-Sterling Steel Co., returning in 1951 as assistant to general superintendent of Gary Sheet & Tin Mill. He was transferred in 1953 to Gary Steel Works as assistant to general superintendent and returned to Pittsburgh in 1956 as assistant to general manager, operations—steel.

Carl Ludwig has been made chief engineer of the Engineered Products Division, Wellman Engineering Co., one of the manufacturing affiliates of McDowell Co., Inc. Mr. Ludwig has been with Wellman since 1956. Previously he was chief engineer with the Rolling Mill Division, Winchester Arms, of Olin Mathieson. He was also with the Adamson Division of Hydropress, Inc.

Obituaries

S. Ein, formerly senior engineer, Inland Steel Co., East Chicago Ind. was killed in an automobile accident in August.

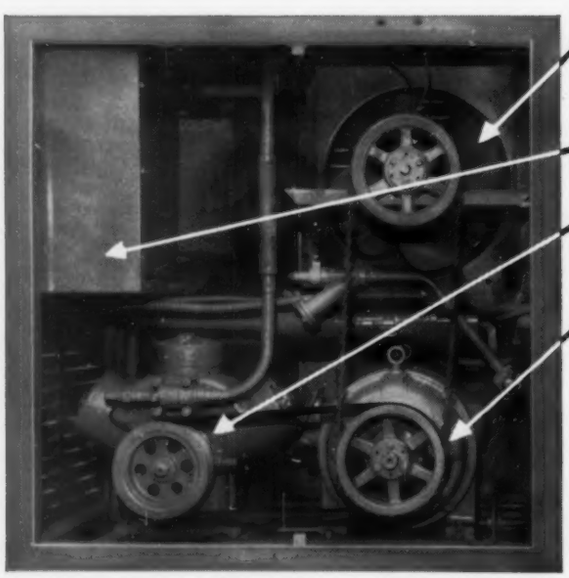
K. A. Daugherty, retired, and formerly with National Tube Co., Chicago District, died recently.

Advance design of Dravo Cab Conditioners

cuts crane downtime

The heavy duty construction and sturdy components of Dravo Crane Cab Conditioners assure dependable service under the most severe operating conditions. This extreme dependability helps to cut costly crane downtime.

Shown at the left is the condenser section of Dravo's 7½ hp conditioner. The large access panels have been opened to show how easily maintenance can be performed from the front of the unit. Also, you can see some of the many features which add to the efficiency and reliability of Dravo Crane Cab Conditioners.



RUGGED CONDENSER-FAN ASSEMBLY—Air is forced, not pulled, through the condenser coils. Thus, when unit is opened for inspection, system operation continues and eliminates maintenance downtime.

DUST-TIGHT CONTROL CABINET—Electrical controls are protected from dirt, dust, and damage.

WEAR-RESISTANT COMPRESSOR—Heavy duty automotive type pistons with full pressure lubrication increase compressor life and efficiency.

HEAVY DUTY MOTOR—Class B insulation (standard equipment on 5 and 7½ hp compressor-condenser fan motors) assures efficient operation despite high ambient temperatures.

For more information about Dravo Cab Conditioners, write for Bulletin No. 1350-33, Dravo Corporation, Pittsburgh 22, Pa.

DRAVO CORPORATION

Charging Box Cars

USS-DESIGNED

to your specifications

United States Steel can build any type of industrial car that is needed in today's modern steel plants. Our staff of engineers specializes in designing cars that meet users' specifications and service requirements.

The four-unit charging-box car, illustrated here, is a good example of a USS-Designed Car. This all-welded steel car has a capacity of 25 tons, and is built for standard gage track. The running gear of this heavy-duty, four-wheel industrial car is equipped with outboard, anti-friction bearings. Car weight, when empty, is 20,300 pounds.

Capacity, running gear, and other design features can be varied to meet your specific needs. In other words, all USS Industrial Cars are custom-made.

Our engineers will be pleased to call at your plant to discuss your requirements for industrial cars. Meanwhile, send for a free copy of our 32-page illustrated booklet—"USS Custom Designed Cars."

Completed charging box car has 25-ton capacity. It is 7' 4" wide x 15' 7" long, on an 84" wheelbase.

Welding underside of car. Steel plate of all-welded car is ¾" to 1¼" thick. Side plates and deck are 1" steel; end plates are 1¼".

Checking thickness of steel underframe. Longitudinal members are 1" plate and the spacers are ¾" plate.

USS INDUSTRIAL CARS

UNITED STATES STEEL CORPORATION, PITTSBURGH
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

UNITED STATES STEEL

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Please send me a free copy of your 32-page booklet, "USS Custom Designed Cars."

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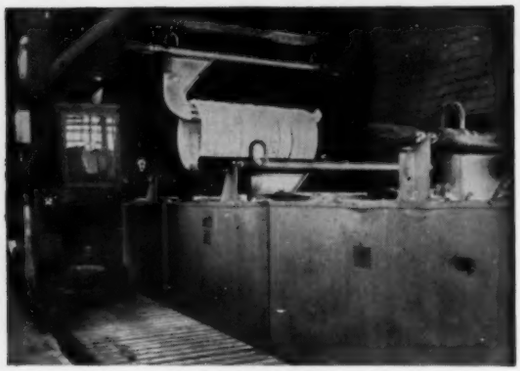
NO PICKLING PROBLEM Too Large or Too Small

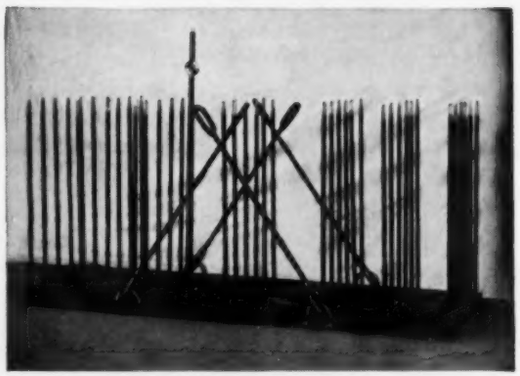
WELDCO Specialists Handle Them All!

IN HUNDREDS OF PLANTS, you'll find Weldco equipment all along the pickling line. For Weldco products are made of corrosion-resisting, hot rolled metals, that withstand attack from hot acids and other pickling solutions. They are strong yet light-weight, wear-resistant, durable, and long-lasting. You get all these advantages when you specify Weldco hooks, mechanical picklers, crates, baskets, racks, chain, steam jets, and accessories.

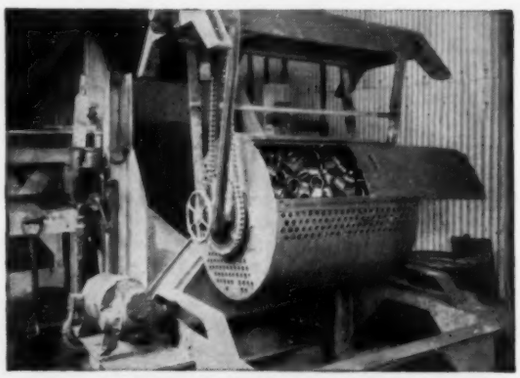
Weldco offers a complete, well-designed line of pickling equipment . . . plus the services of our experienced staff. Let Weldco engineers take care of all your pickling needs. For any problem, large or small, they have the practical, cost-cutting answer.



Weldco Pickling Hooks



Weldco Sheet Pickling Crate



Weldco Mechanical Drum Pickler

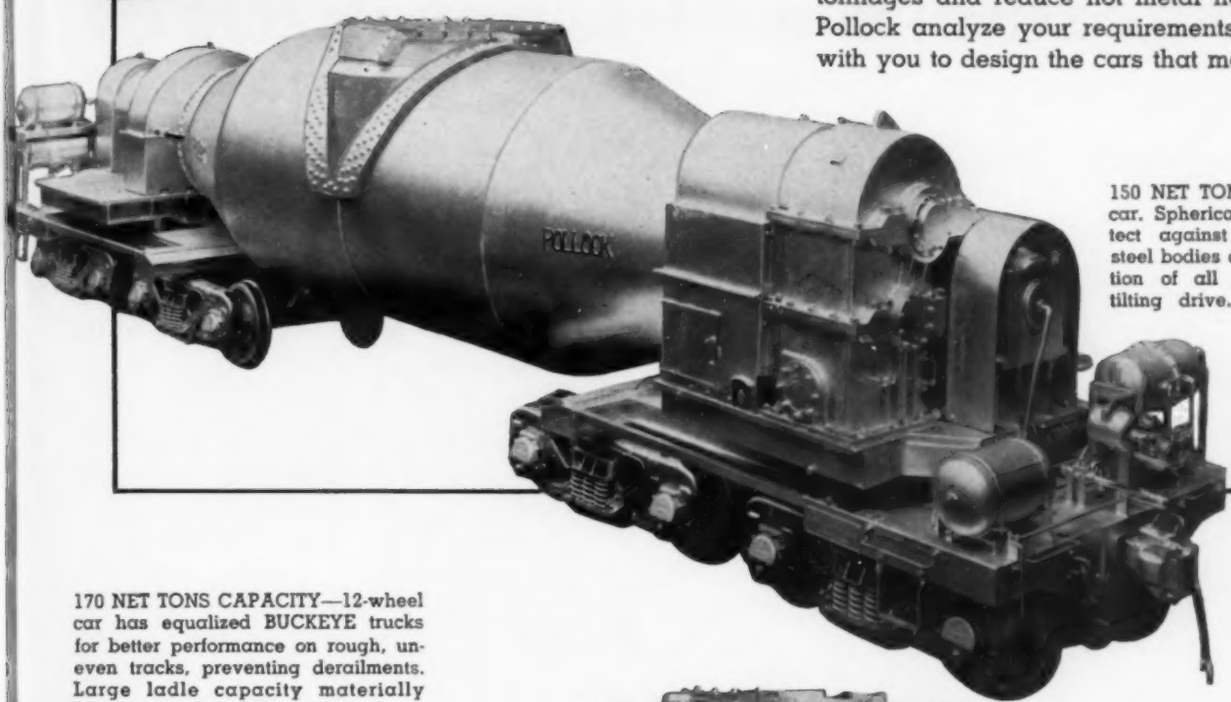
Weldco Monel Chain

THE YOUNGSTOWN WELDING & ENGINEERING COMPANY

3724 OAKWOOD AVE. • YOUNGSTOWN 9, OHIO

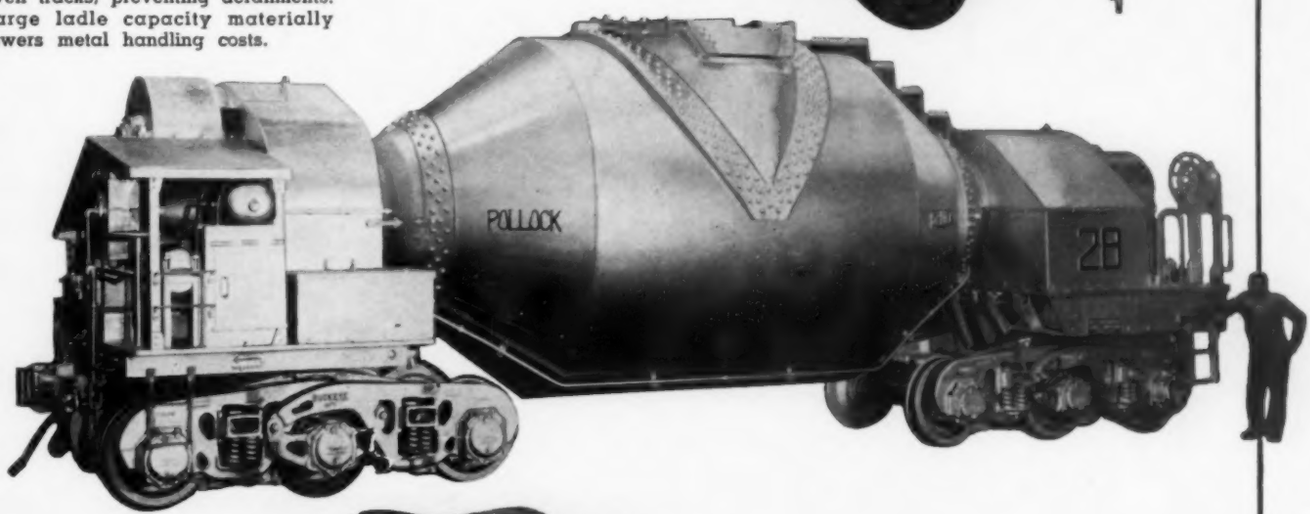
POLLOCK hot metal cars

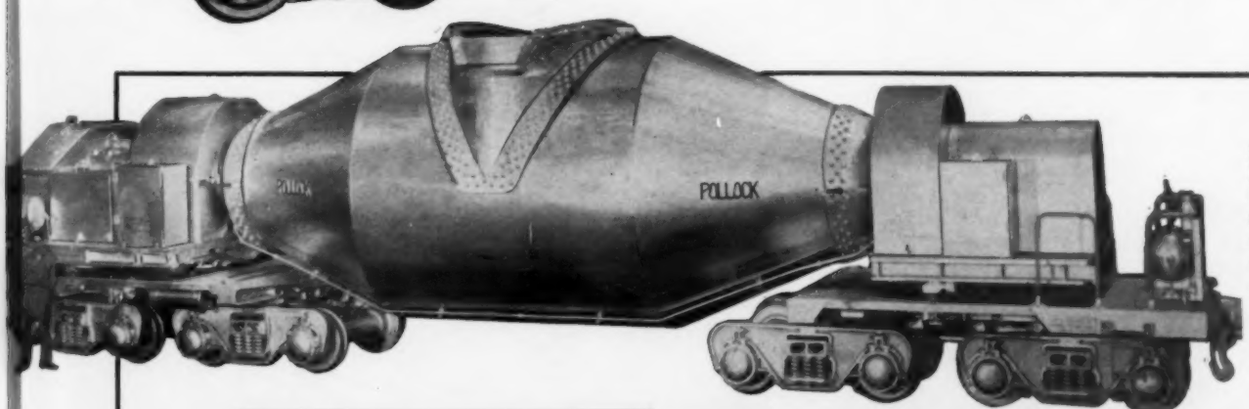
These are America's newest, BIG, hot metal cars. Pollock designed and built this type car to carry large tonnages and reduce hot metal handling costs. Have Pollock analyze your requirements. Pollock will work with you to design the cars that meet your needs best.



150 NET TONS CAPACITY—16-wheel car. Spherical trunnion bearings protect against misalignment. Welded steel bodies and ladles. Pump lubrication of all gears and bearings in tilting drive.

170 NET TONS CAPACITY—12-wheel car has equalized BUCKEYE trucks for better performance on rough, uneven tracks, preventing derailments. Large ladle capacity materially lowers metal handling costs.





200 NET TONS CAPACITY—America's largest. Dumping mechanism is completely covered. Car designed to meet specific plant conditions. Air brakes if desired.

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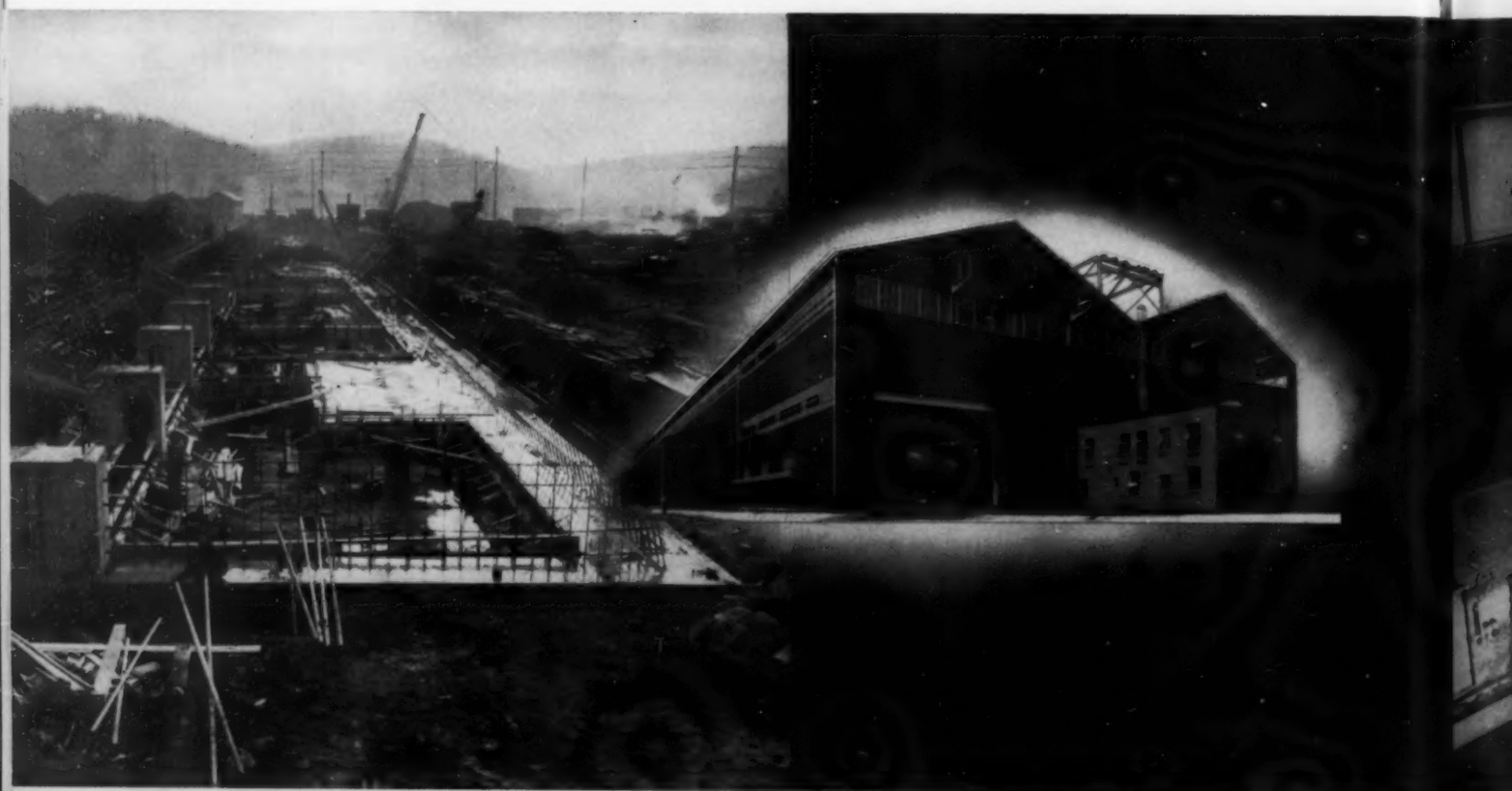
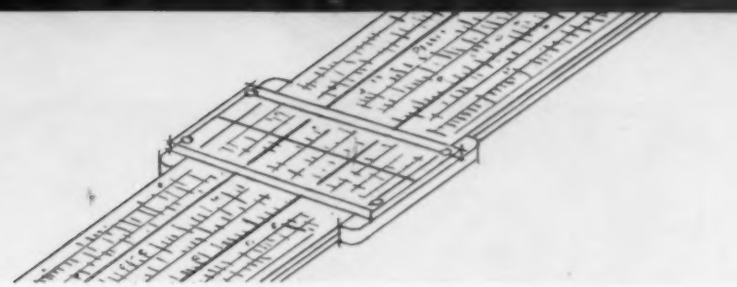
SWINDELL-DRESSLER CORPORATION

ELECTRIC MELTING DEPARTMENT





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Your inquiries are invited on complete Melting Department design and construction, modernization or re-equipment by this experienced organization. We will be glad to consult with you on providing cost studies, design engineering, construction management, equipment manufacture and procurement—any or all phases of your contemplated project. Write us in confidence for preliminary discussions.

Specify... **J-M Asbestos Wick** **J-M Asbestos Rope**

Wherever you need general utility packings that are easy to handle, highly heat resistant

Throughout the iron and steel industries, the list of uses for Johns-Manville Asbestos Wick and Rope is constantly growing. These soft, resilient, heat-resisting materials are widely employed for general packing, gasketing and caulking applications.

In coke ovens, both are used to caulk around the doors to prevent the escape of gases. Asbestos Rope (Style 4200) also serves as expansion joint material in the brickwork.

Only a few of the many applications for Asbestos Wick (Style 4202) can be given here. It seals hot metal in the ingot mould, around the top and between the mould and the stool. It gives protection from burning to water hoses that cool Open Hearth doors. It serves as a seal between the cope and drag on moulding flasks. It is used to wipe excess coating from wires after passing through the galvanizing bath.

Styles 4200 and 4202 are made from pure asbestos fibre carefully controlled for quality at Johns-Manville's own mine and mill (largest in the world). Asbestos Rope is formed by twisting together two or more strands of Wick to obtain the desired thickness. For further information, call your local J-M distributor or write Johns-Manville, Box 14, New York 16, N. Y. In Canada, Port Credit, Ontario.

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1. READY-TO-USE. Add only water to Embeco Pre-Mixed Grout, mix and place to produce a...

2. . . . FLOWABLE easily-placed grout that hardens as a . . . .

3. . . . NON-SHRINK grout of high compressive and impact-resistant strength.

EMBECO PRE-MIXED GROUT

. . . Gives *lasting* results on every grouting job: heavy equipment, machinery, anchor bolts, building columns, bridge seats, etc.

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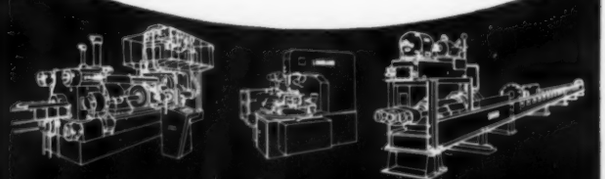
Designers, Builders and Erectors for the Ferrous and Non-Ferrous Industries



As machinery builders and engineers . . . Lombard assumes full responsibility for your project, whether it be a single piece of equipment or an entire plant installation. When you are considering metal working machinery, design engineering or production methods . . . contact Lombard. Your inquiry will receive prompt attention.

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LOMBARD CORPORATION

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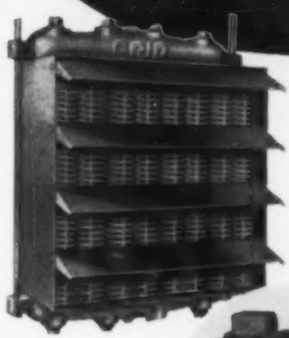
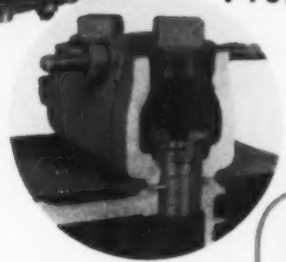
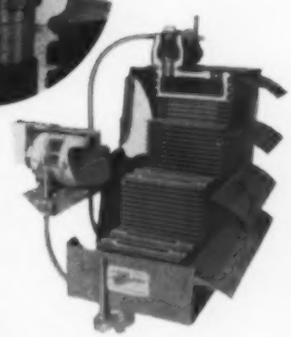
GRID Cast Iron-Steam Heat Transfer Surface



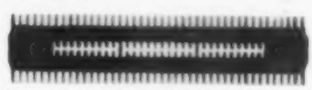
. . . ends Unit Heater Maintenance Problems!



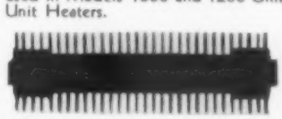


Your answer to unit heater problems the steel industry has discovered through common failures of copper, aluminum and steel tube heat transfer surface. GRID condenser eliminates internal electrolytic corrosion—because all metals in contact with steam are similar. GRID also eliminates external corrosion—because the cast iron construction resists acid or other fumes in the air and eliminates the use of reducing valves where high steam pressure is used. GRID cast iron construction is tested to withstand steam pressures up to 250 P.S.I. . . .450° temperature . . . no soldered, brazed, welded or expanded connections . . . a specially designed threaded nipple provides a leakproof joint. GRID eliminates the high maintenance costs generally experienced with other types of condenser construction. . . eliminates replacement costs because GRID is built to last for years . . . uninterrupted service records of more than twenty years are common among GRID users.

Cut-away view of Model 2000 GRID Unit Heater . . . note double steam chambers in each fin section and wide fin spacing.



Note wide fin spacing and ample radiation surface in all cast iron, one-piece, single chamber fin sections, used in Models 1000 and 1200 GRID Unit Heaters.



All cast iron, one-piece, double chamber fin sections used in Models 1500 through 3000 GRID Unit Heaters. . . wide fin spacing prevents clogging and is easily cleaned.

Send for the complete story on GRID Unit Heaters, GRID Blast Heaters and GRID Radiation for steel industry use. . .it is contained in GRID Products Catalog No. 956. Write today for your copy.

D. J. MURRAY MANUFACTURING CO.

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WAUSAU, WISCONSIN

NEW!

. . . a triumph in mill motor design!

■ round fabricated steel frame

Compact, rugged split-frame construction assures rigidity, durability and easy access.

■ silicone-insulated windings

All windings are Class H silicone insulated, capable of taking the severest kind of abuse.

■ greater power

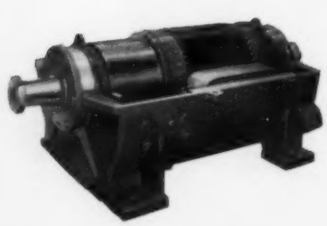
The new Elliott Crocker-Wheeler 620 is an addition to the mill motor line—more powerful than any previous design.

available now!

This is the recently standardized AISE 620 frame mill motor, and is now in production. Can be furnished as totally enclosed; protected self-ventilated; or as protected or enclosed forced-ventilated.

LEFT—The new 620 mill motor arranged for protected forced ventilation, with motor-driven blower and filter.

RIGHT—Split-frame construction permits easy access for maintenance and repair



W7-4

ELLIOTT Company

JEANNETTE,
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ELLIOTT CROCKER-WHEELER

620 MILL MOTOR

Call the Elliott Man

at your nearby Elliott District Office or write the Elliott Company, Crocker-Wheeler Division, Jeannette, Pa. ASK FOR BULLETIN PB 9000-2.

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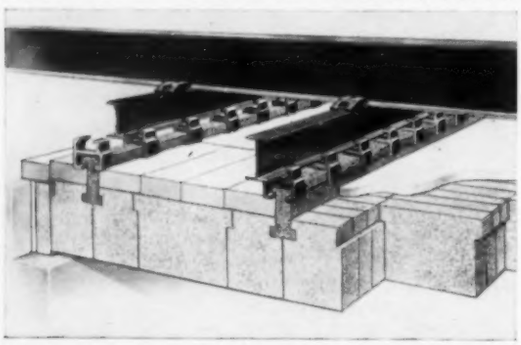
WE ARE "PACKAGERS" OF HEAT

WITH A 45-YEAR RECORD OF SERVICE TO AMERICAN INDUSTRY

We have specialized for 45 years in the design of heat enclosures for industrial furnaces, boilers and other units employing heat. In that time we have met every conceivable problem, served the biggest, most successful companies in industry, and pioneered an impressive group of basic advances in heat enclosure materials and techniques. All this experience goes to work for you when you bring your heat enclosure problems to Detrick, along with the assurance of engineering that contributes much to the life and performance of the unit. The Detrick story is yours for the asking. Ask for it today.

NEW DEVELOPMENT IN ARCH CONSTRUCTION



Insulating Refractory Arch—the last word for units requiring low heat storage and close control of temperature cycle. Featuring a dense refractory hanger and maximum insulation cover. Write for descriptive Bulletin—Type ALR.

M. H. DETRICK COMPANY

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Detrick service includes engineering, materials and field inspection of the installation.

DETRICK Heat ENCLOSURES

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HEAT ENCLOSURES

PRECISION

It's fine to have the giant equipment for heavy machining jobs. But equally important—it's vital to have the skilled workmen and engineering know-how for *precision* performance. We're proud to offer this unusual combination for *your* machining requirements on jobs that are big and tough to handle. (Illustration shows a blast furnace bell on a 20′0″ vertical boring mill.)

"Electric and Open Hearth Steel Castings from 1 lb. to 100 tons"

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ENGINEERING & MACHINE CO.

Division of Pittsburgh Steel Foundry Corporation

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You name your wire production needs . . .

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A Vaughn consultation on your forthcoming wire production requirements can point the way to profits! Our complete resources are at your disposal—our experience is your assurance of constructive help. *Call us, without obligation of any kind.*

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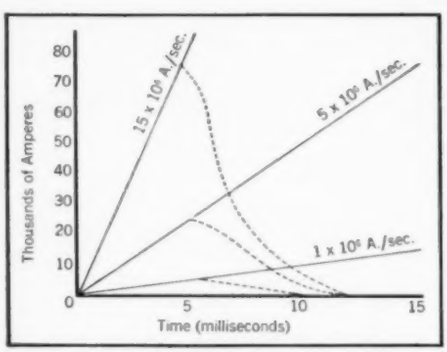
COMPLETE COLD DRAWING EQUIPMENT—Continuous or Single Hole . . . for the Largest Bars and Tubes . . . for the Smallest Wire . . . Ferrous, Non-Ferrous Materials or their Alloys

D-C CIRCUIT BREAKERS

Type FB-20 single pole circuit breaker: 2000 amperes continuous, 1000 volts d-c.

NEW "FB" CURRENT LIMITING CIRCUIT BREAKER

Now...complete current limiting protection against fault currents of 1000 to 150,000 amperes



Peak let-through current for FB circuit breaker with 1000 ampere trip.

Small in size, these FB d-c circuit breakers with fast current limiting action provide a tremendous protective capacity. In the event of a fault, powerful springs open the contacts before the current has a chance to rise to its maximum potential.

Even in circuits where the rate of rise might approach 15,000,000 amperes per second, let-through current will not exceed 80,000 amperes. In most applications, it will never exceed 30,000 amperes—and total interrupting time is only 12 milliseconds. This quick action reduces the magnitude and duration of fault currents—thus eliminating mechanical failures and heat damage.

FB circuit breakers are available in either single or double pole models and with continuous current ratings of 1200, 2000, 3000 and 5000 amperes and up to 1000 volts d-c. They are available with either stationary or drawout mounting. Write for Bulletin 3004-A. I-T-E Circuit Breaker Company, Switchgear Division, 19th & Hamilton Sts., Philadelphia 30, Pa.

I-T-E CIRCUIT BREAKER COMPANY • Switchgear Division

IN CANADA: EASTERN POWER DEVICES LTD.

Exclusive with the Heroult:

Operating Mechanism Independently Supported

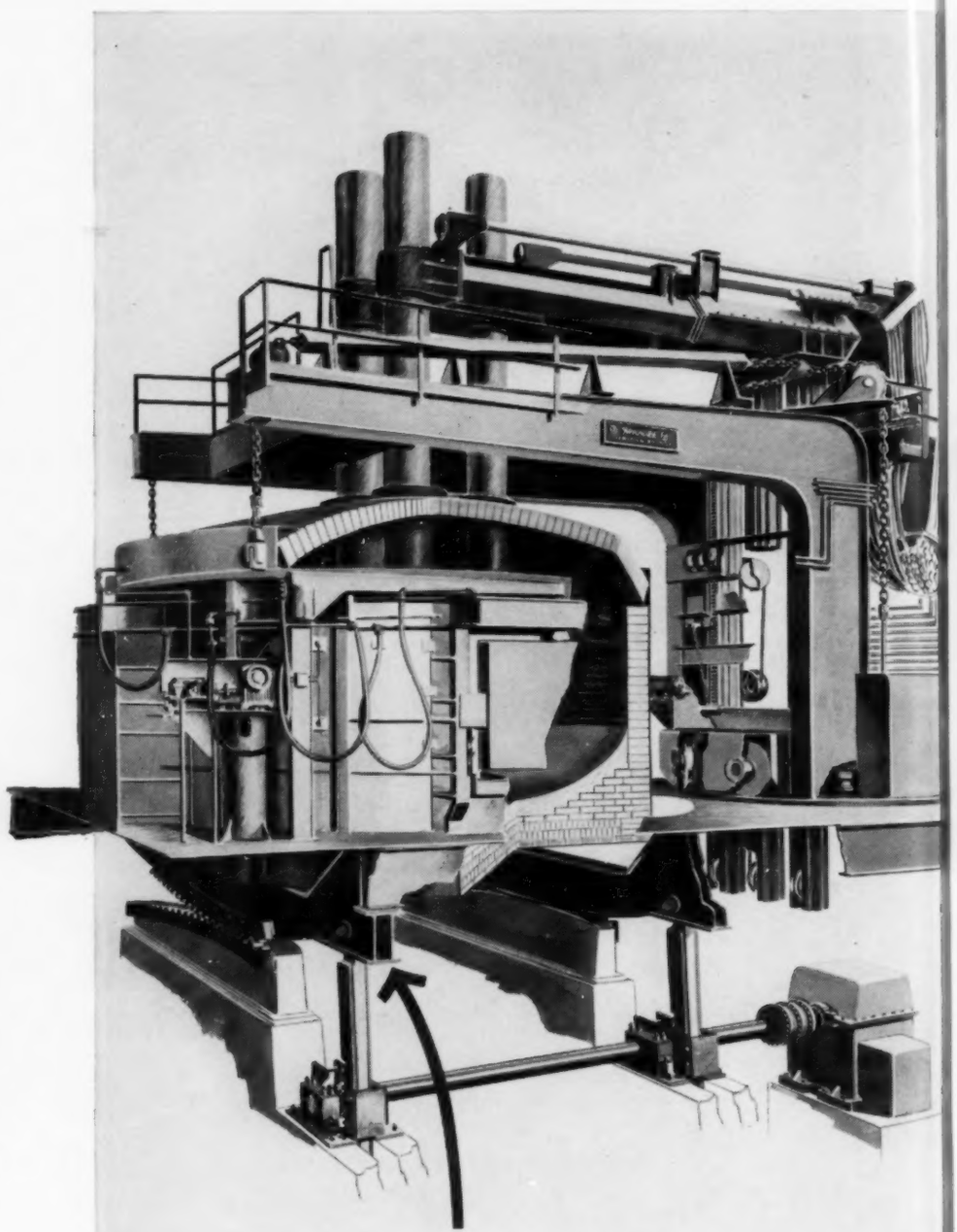
In Heroult's specially designed **new** furnaces the operating mechanism is located on the tilting platform, supported on rockers completely separate from the cage shell. In the event of shell warpage due to overheating, the mechanism remains unaffected and efficient production continues free from maintenance delays.

The independently supported operating mechanism which contributes to lower operating costs, and helps cut maintenance outlays to a fraction of former rates, is only one of the advanced design exclusives offered by the **new** Heroult for increased production efficiency. There are four others ready to operate on your behalf:

1. **Flat-bottom shells, for simplified relining jobs and good bath temperature distribution.**
2. **Water-cooled skew back roof ring, eliminates need for special roof refractories.**
3. **Cage-type shell construction, minimizes shell distortion and facilitates replacement of damaged shell plates.**
4. **100% mechanical operation, for reliability and ease of maintenance.**

There is a wide range of **new** Heroult Furnaces with shell sizes from 7'0" up, and with capacities from 6000 to 400,000 pounds. You can obtain them with non-magnetic induction stirring equipment, top charge, door charge, and special duplexing. Non-ferrous furnaces are also available.

The pioneers and leaders in this field for 51 years, Heroult specialists in electric furnaces can help you select and install the equipment best suited to your current and future needs. Get in touch with our nearest contracting office—today—for complete information.



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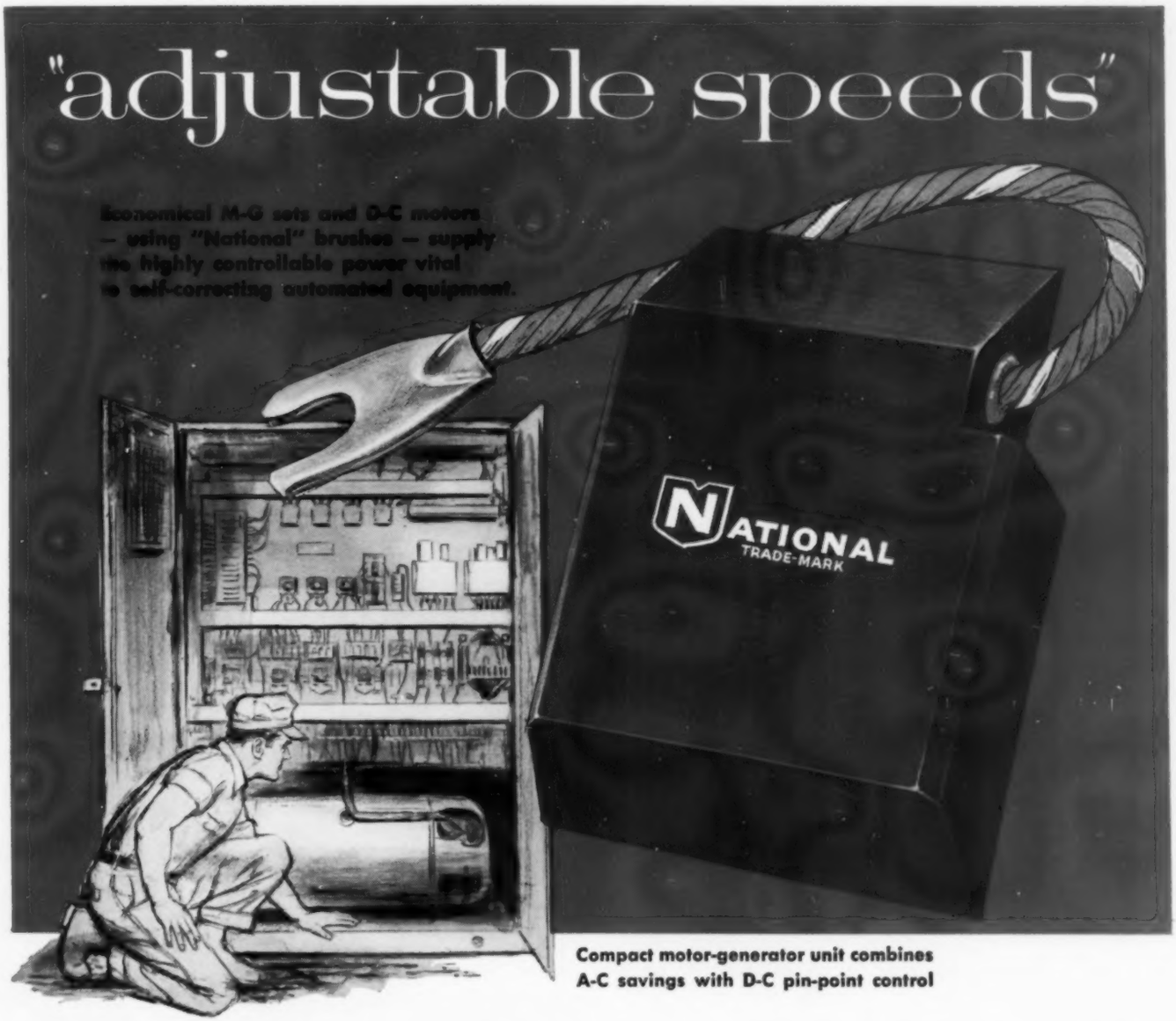
Heroult
ELECTRIC MELTING FURNACES

UNITED STATES STEEL

NATIONAL BRUSHES HELP SOLVE AUTOMATION'S BIGGEST PROBLEM:


"adjustable speeds"
Economical M-G sets and D-C motors — using "National" brushes — supply the highly controllable power vital to self-correcting automated equipment.
NATIONAL
TRADE-MARK

Compact motor-generator unit combines A-C savings with D-C pin-point control

Why these NATIONAL brush grades are best for automation:

SA-45 SA-35 N-4

- Superior commutating ability over a wide speed range
- Brush uniformity assures consistent machine performance
- Superior brush operation reduces expensive down-time and equipment maintenance

See your "National" Brush Man when you're selecting carbon brushes. He has a brush for every need, plus the experience and backing to help you assure continuous good performance.

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From one source . . . any instrumentation you need

When it comes to measurement and control, every industrial process is different. Each demands its own combination of accuracy, economy, instrument ranges and all the numerous other characteristics that are peculiar to the individual application.

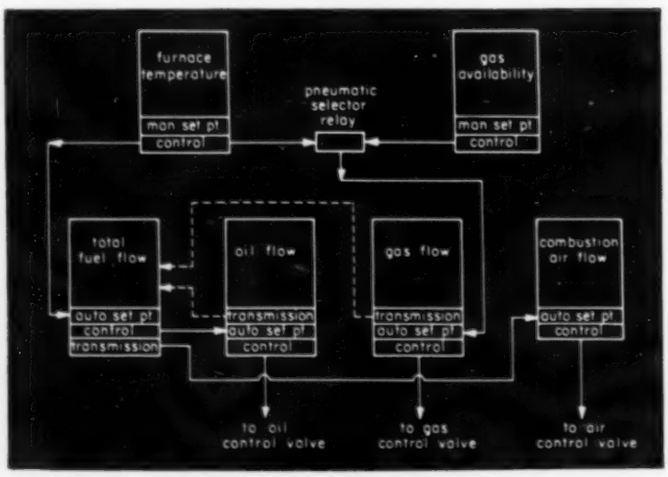
No single instrument and its accessories could possibly fit every process. So Honeywell makes a broad variety of measuring and controlling equipment that spreads across a tremendous range of applications.

The advantages are two-fold. First, you can get all the instrumentation your process requires from a single source, so there is undivided responsibility for the complete installation. And second, you are assured that the equipment selected for your process is recommended without bias . . . neither over-sells nor under-equips . . . needs no stretching, squeezing or compromising to fit it to its assignment.

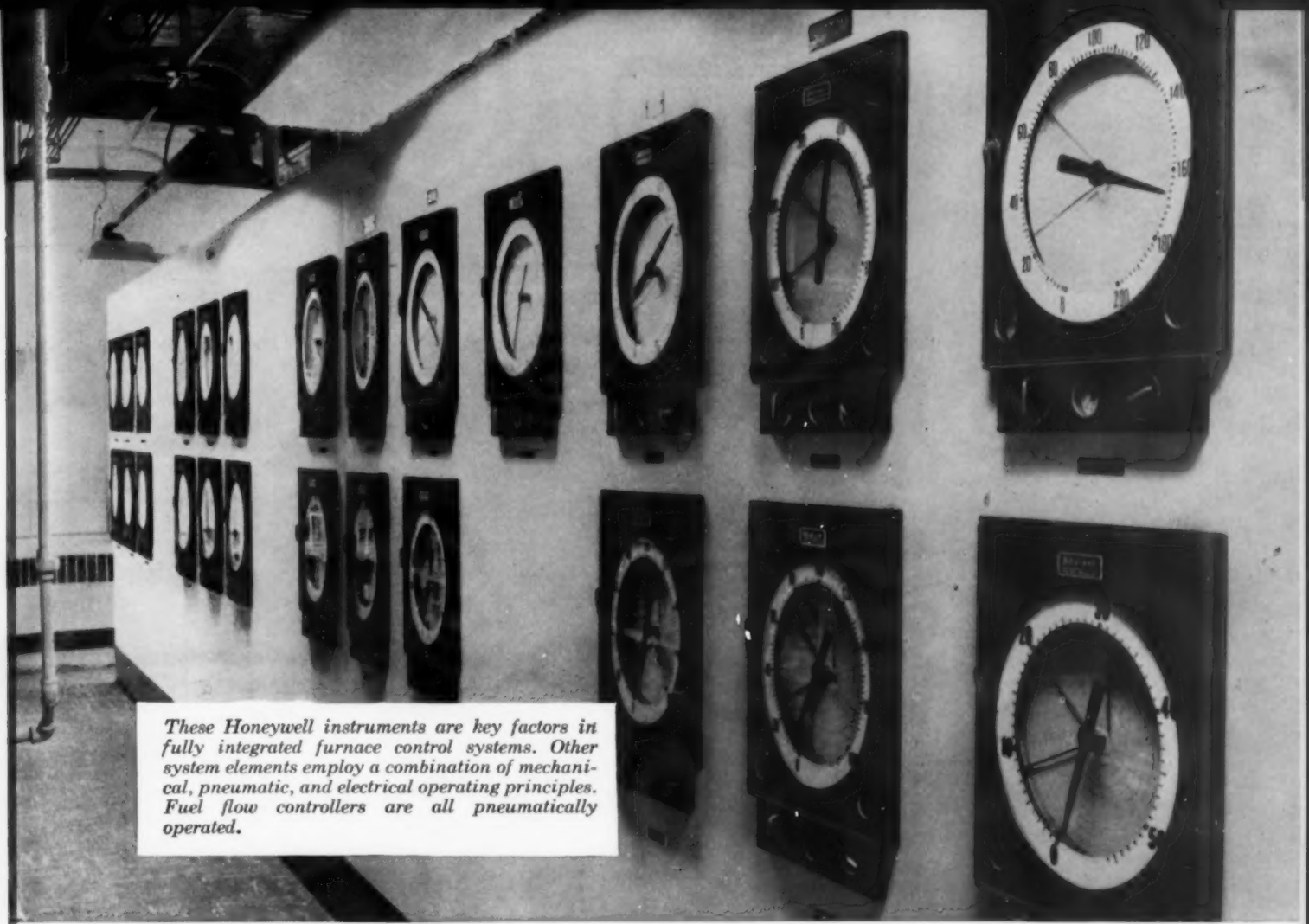
This versatile family includes *ElectroniK* indicators, recorders and controllers in circular and strip chart models, applicable to temperature, pressure, pH, power and dozens of other variables; square root flow meters for control applications; evenly graduated flow meters for cost accounting; thermometers, pressure gages and liquid level meters; *Pyr-O-Vane* millivoltmeter controllers. Especially useful for graphic panels are the *Tel-O-Set* miniature indicators, recorders and controllers. Electric and pneumatic control systems range from the simplest to the most complex, including automatic program controls and complete systems developed for particular processes.

Working with these instruments is a full choice of primary elements . . . thermocouples, *Radiamatic* radiation elements, pressure-type and electrical resistance thermal systems, flow meter bodies, pH cells and many others. For final control elements, you can choose from a wide range of electric motorized and diaphragm operated valves. To complete the picture, there are more than 7000 non-indicating devices for controlling temperature, pressure, vacuum, liquid level and humidity . . . an unmatched variety of instrumentation made by the world's largest manufacturer of control equipment.

Honeywell-engineered reheating furnace control system . . .



Control system for triple-fired, three-zone slab reheating furnace.



These Honeywell instruments are key factors in fully integrated furnace control systems. Other system elements employ a combination of mechanical, pneumatic, and electrical operating principles. Fuel flow controllers are all pneumatically operated.

puts byproduct gas to work

A large Eastern steel mill was faced with the problem of how to economically use its large quantities of byproduct gas fuels. A Honeywell-engineered control system provided the economical solution. The system puts byproduct gas fuel to work on the basis of its availability, automatically adjusting the combustion system as required. It adds the right amount of oil fuel to gas to make up the total fuel demand. And it maintains correct fuel-air ratios, automatically, under all firing conditions.

Manual control of furnaces was exceedingly difficult for two reasons. First, much of the gas was fed to multiple-fuel reheating furnaces, and surplus gas often varied widely and rapidly in availability. And second, fuel oil was used to make up the difference between furnace fuel demand and available byproduct gas fuel. Simultaneous balancing of the quantity of each fuel was needed to satisfy temperature and load demands of reheating furnaces.

Time that used to be spent coping with fuel problems now is concentrated on furnace operation and product quality. Personnel training and trouble-shooting have been simplified by the use of instruments of familiar design and construction. Maintenance of the complete interlocked control system, even in this steel mill environment, is no greater than that required for single instruments.

In your own plant, instrumentation by Honeywell can lead directly to important economies and upgraded product quality. Your nearby Honeywell sales engineer can give you the facts and figures . . . and he's as near as your phone.

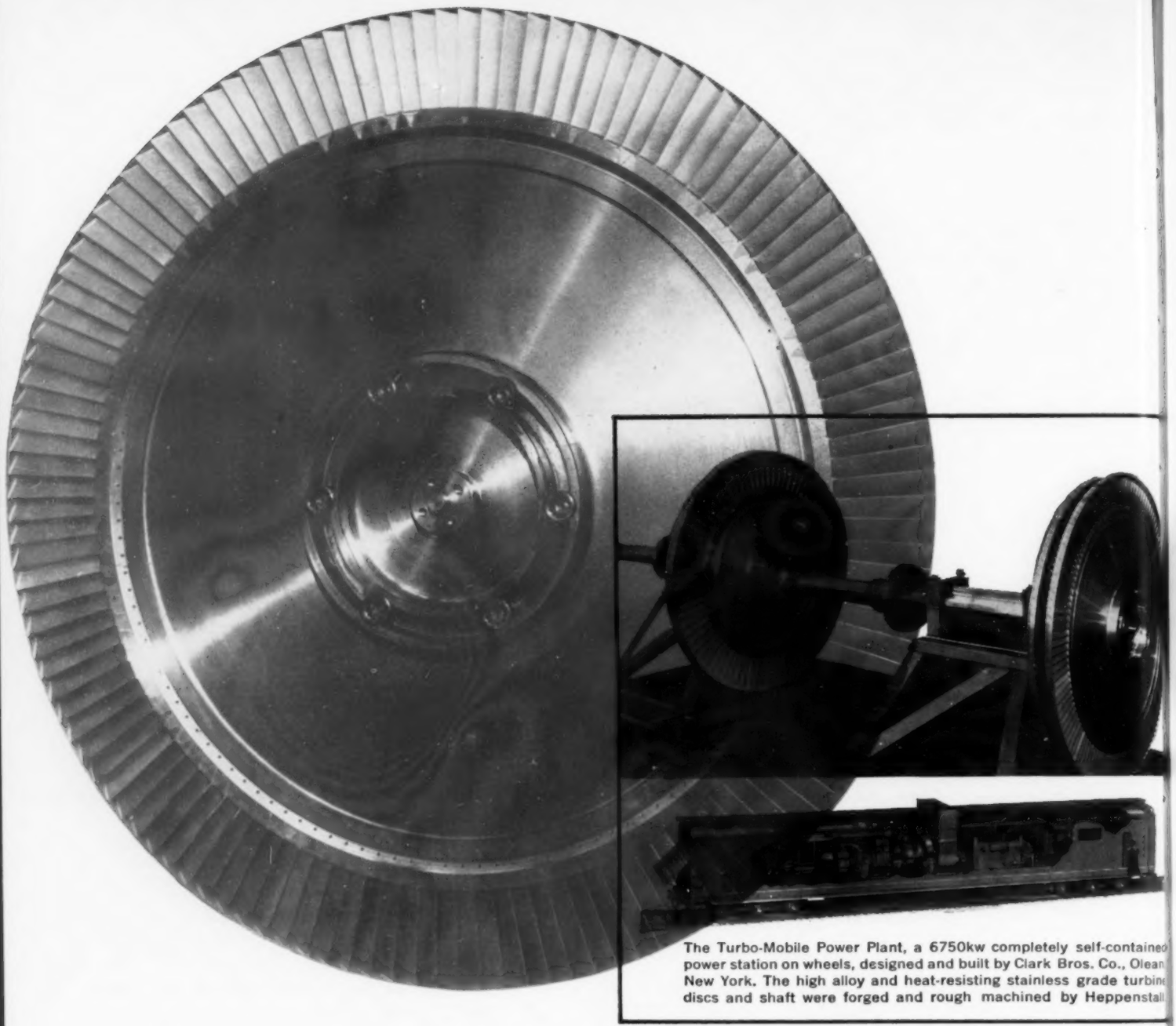
MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.

H HONEYWELL

MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS

First in Controls



The Turbo-Mobile Power Plant, a 6750kw completely self-contained power station on wheels, designed and built by Clark Bros. Co., Olean, New York. The high alloy and heat-resisting stainless grade turbine discs and shaft were forged and rough machined by Heppenstall.

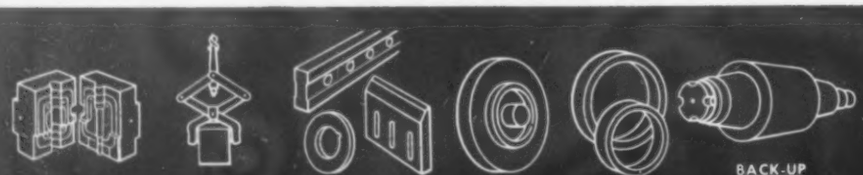
Heppenstall Forgings add reliability to Clark Power Plant Gas Turbine discs

Ingenious design and engineering have solved the problem of rapid restoration of power following natural disasters and war damage . . . or temporary power for fast growing residential or industrial areas. A Clark 6750kw gas turbine power plant can now roll in at normal rail speeds and put power on the line in the little time required to connect fuel and power outlet lines. It *must* be dependable, that's why the turbine discs used in driving the axial compressor and generator are Heppenstall Forgings.

Heppenstall Forgings, in any shape you may require, are made from special Heppenstall open hearth carbon and alloy steels, or high alloy and heat resisting stainless steels from Heppenstall Electric Induction Furnaces.

These Forgings must pass rigid inspection and ultrasonic testing . . . your assurance that each Heppenstall Forging becomes a trouble-free component of your product. And the satisfied user becomes a steady customer.

For the full story of how Heppenstall Forgings can build quality and performance into *your* product . . . and your production machines . . . contact your Heppenstall Company Representative.



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. . . the most dependable name in forgings

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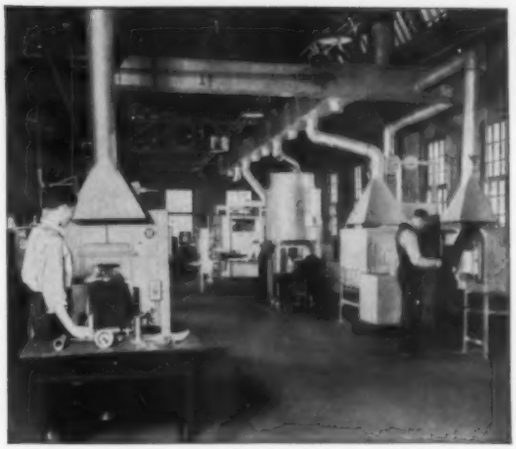
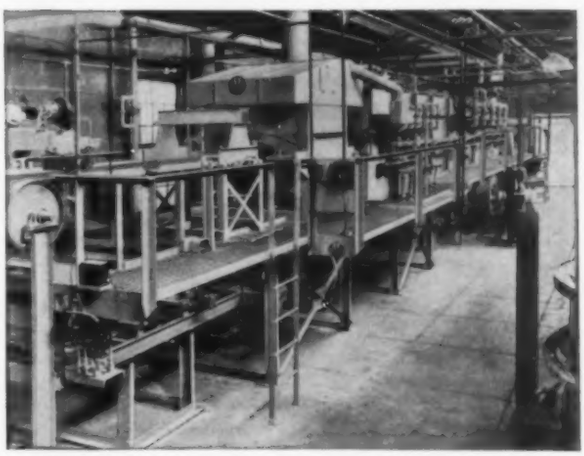


General view of the research department showing several of the continuous and batch type experimental furnaces.



View of combination gas-fired and electric continuous furnace equipped with flame preheating burn-off or oxidizing section and controlled heating, soaking and cooling zones, for producing various surface conditions on strip.

● The EF research department is equipped with gas-fired, oil-fired and electrically heated continuous and batch units including,—continuous wire mesh furnaces;—endothermic and exothermic special atmosphere generators;—forced circulation bell furnaces;—a continuous roller hearth furnace for treating commercial widths of ferrous and non-ferrous strip;—and other equipment.

Consequently,—from test runs—we can determine accurately the combination of temperature, time cycle, atmosphere and other factors needed to produce the exactly desired results,—assuring—in advance—the efficient performance of EF furnaces *fully up to specifications.*

Many large companies have drawn liberally upon this department in developing new products, and new techniques. Our facilities are available to YOU also—for YOUR research or development work, either gratis or for a moderate fee, depending upon the nature of the experiment. We will be glad to schedule time for your technicians.

Write today for our 12 page booklet, "Research Facilities". It describes the equipment we can place at your disposal.

Direct gas-fired forced circulation bell type furnace for processing wire, rod, strip and other products.

Gas-Fired, Oil-Fired and Electric Furnaces

for any Process, Product or Production

THE ELECTRIC FURNACE CO.

WILSON ST. at PENNA. R. R. *Salem - Ohio*

Canadian Associates • CANEFCO LIMITED • Toronto 1, Canada

VICTOR R. BROWNING
MILL TYPE CRANES

to Specification..

Basically designed as required by A.I.S.E. specifications, mill type cranes built by Victor R. Browning & Co., Inc. also offer the opportunity of specifying preferences and standards prevailing in the purchaser's plant. May we have your next inquiry?

VICTOR R. BROWNING & COMPANY, Inc.
WILLOUGHBY (CLEVELAND), OHIO
DESIGNERS AND BUILDERS OF ELECTRIC OVERHEAD TRAVELING CRANES AND HOISTS AND ELECTRIC REVOLVING CRANES

HEAT MORE STEEL with MORGAN-ISLEY

The Morgan-Isley system offers you a better means of heating ingots with straight blast furnace gas, coke oven gas, natural gas or oil.

The schematic shows the flow of combustion air and flue gases through the regenerators and soaking pit. The Morgan-Isley system employs vertical regenerators. It eliminates regenerator capacity under the crane runway thus freeing this valuable area for heating steel.

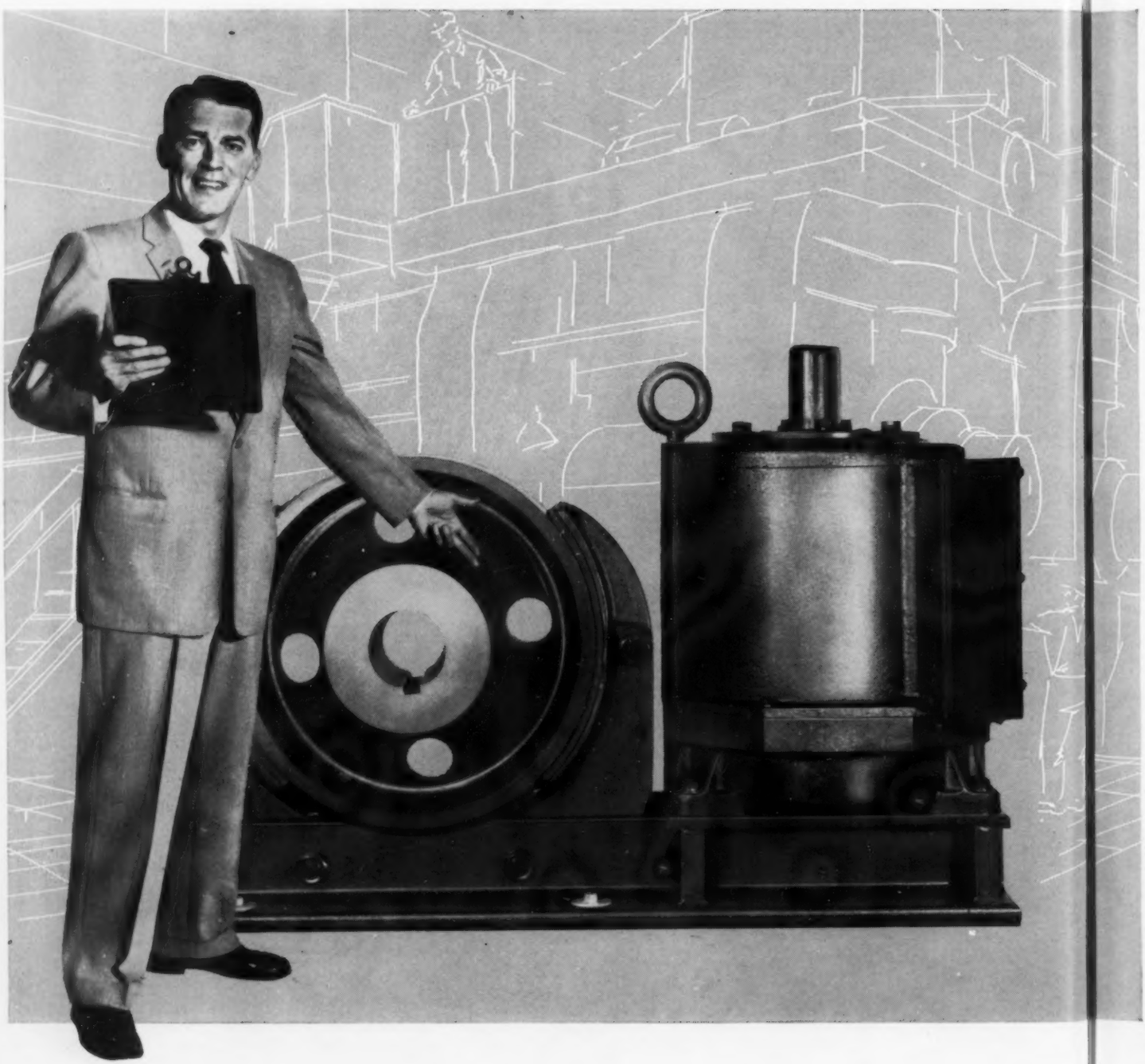
CCC-49

MORGAN CONSTRUCTION COMPANY WORCESTER, MASS.

ROLLING MILLS • MORGOIL BEARINGS • REGENERATIVE FURNACE CONTROLS • EJECTORS • PRODUCER GAS MACHINES

H.H. Wood, Representative, Koppers Building, Pittsburgh, Pennsylvania

Westinghouse offers: the only self-adjusting



D-C magnetic brake

Simplicity of construction— minimum number of parts means years of trouble-free operation

Now, brake adjustment problems are gone forever. With Westinghouse exclusive self-adjusting d-c magnetic brakes, the need for adjustment is eliminated—for the life of the brake lining.

Regardless of lining wear—or wheel expansion—the SA brake shoe is always in correct adjustment and proper alignment.

Field tests show self-alignment of SA brakes permits even lining wear—shoe tips cannot drag. Lining life is increased up to 50%. Wheel wear and scoring are minimized for longer wheel life.

For complete information on industry's most advanced d-c magnetic brake, call your WESTINGHOUSE sales engineer. Or, write Westinghouse Electric Corporation, 3 Gateway Center, P.O. Box 868, Pittsburgh 30, Pennsylvania. Ask for B-6547.

J-22048

YOU CAN BE SURE...IF IT'S Westinghouse

Westinghouse mill motors with silicone insulation

are giving top performance on the toughest applications. Silicone insulation plus greater capacity and cooler operation of improved field coil design . . . heavy-duty shaft, bearing and housing design to take high torque loads . . . give you longer, more dependable motor life with Westinghouse Hevi-duty Mill Motors. For all the details, ask for B-6547.

Which of these Model W ELECTROLYTIC MOISTURE ANALYZERS do you need?

STANDARD UNIT

Shown with Model A Oil Separator and Model I Vaporizing Valve mounted on side panel.

EXPLOSION-PROOF UNIT

Available with or without thermostatic controls.

Many other types also available for measuring moisture content down to better than 1 part per 1,000,000!

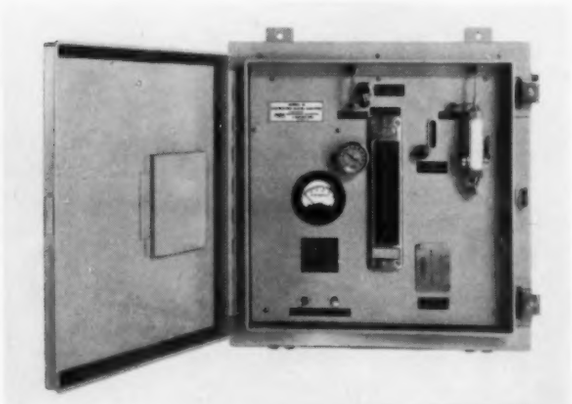
Rapid adoption of the *Meeco* Model W Electrolytic Moisture Analyzer has made possible the introduction of many different types — to fit most any requirement you have.

New types (in addition to those shown) include relay rack units . . . units for flush panel mounting . . . and units for measuring moisture in liquids — in either standard or stainless steel construction.

Instruments for automatic control of moisture content of gases are also available.

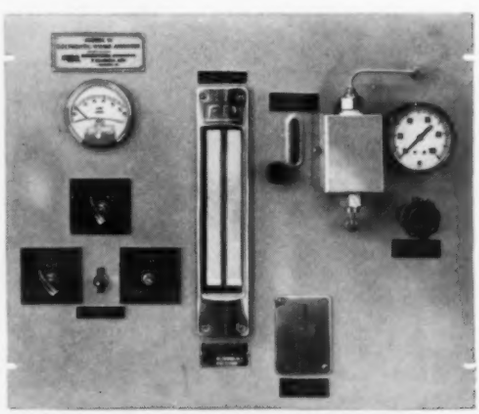
Any of these units can be obtained with calibration in parts per million by volume or pounds per million standard cubic feet. All are available in extended ranges, and measure moisture content of a versatile range of gases on an absolute basis. Conversion curves to dew point indication can be obtained on request.

Write us today for complete information on the model that is best suited for your own particular purpose.



WEATHER-PROOF UNIT

For fixed or portable installation — available with or without thermostatic controls and insulation. Battery operation optional.



TYPICAL RELAY RACK PANEL UNIT

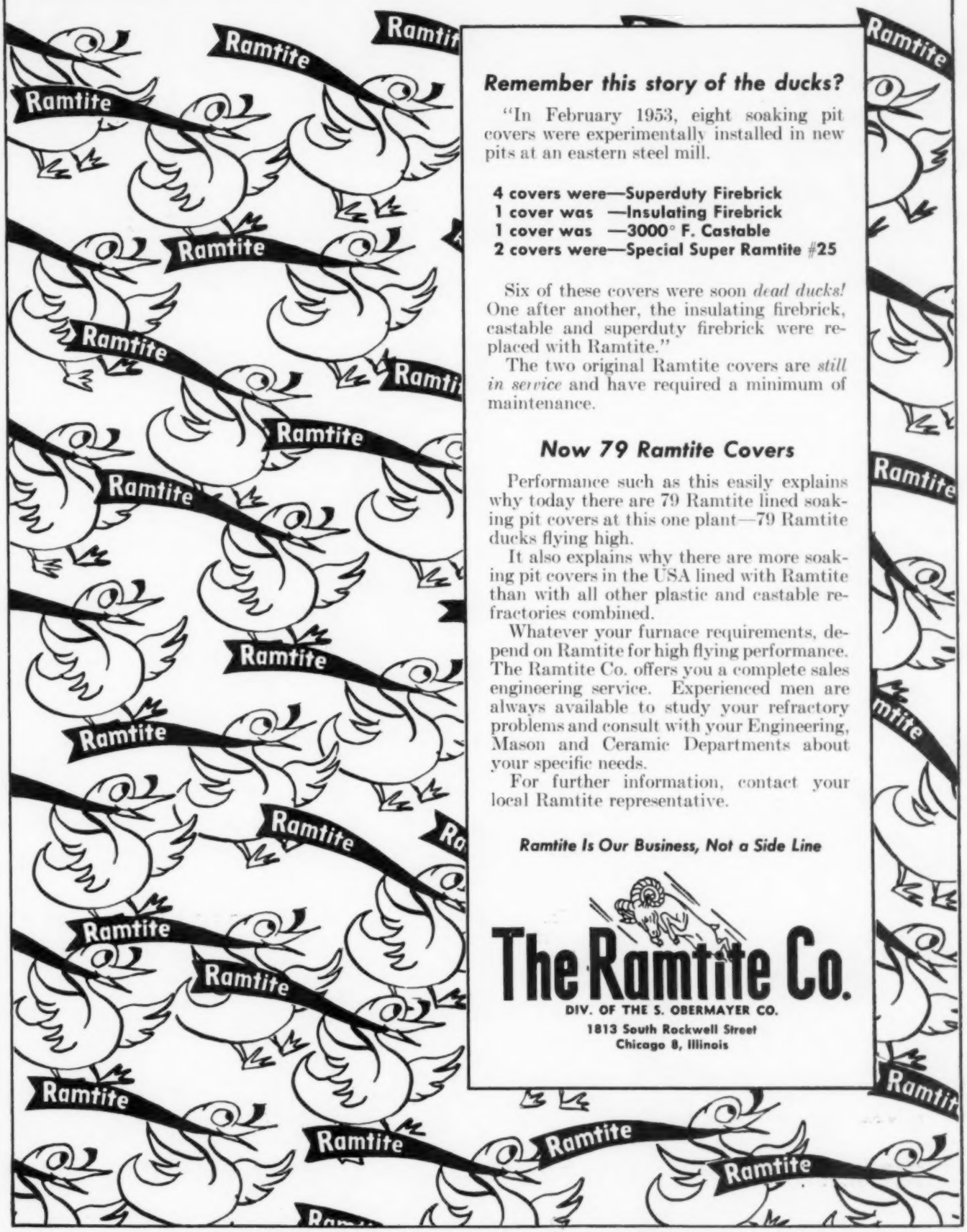
Shown with Model I Vaporizing Valve.

MANUFACTURERS ENGINEERING & EQUIPMENT CORP.

Hatboro • Pa.

MEECO Instruments

DON'T BUY A DEAD DUCK!



Remember this story of the ducks?

"In February 1953, eight soaking pit covers were experimentally installed in new pits at an eastern steel mill.

4 covers were—Superduty Firebrick
1 cover was —Insulating Firebrick
1 cover was —3000° F. Castable
2 covers were—Special Super Ramtite #25

Six of these covers were soon *dead ducks!* One after another, the insulating firebrick, castable and superduty firebrick were replaced with Ramtite."

The two original Ramtite covers are *still in service* and have required a minimum of maintenance.

Now 79 Ramtite Covers

Performance such as this easily explains why today there are 79 Ramtite lined soaking pit covers at this one plant—79 Ramtite ducks flying high.

It also explains why there are more soaking pit covers in the USA lined with Ramtite than with all other plastic and castable refractories combined.

Whatever your furnace requirements, depend on Ramtite for high flying performance. The Ramtite Co. offers you a complete sales engineering service. Experienced men are always available to study your refractory problems and consult with your Engineering, Mason and Ceramic Departments about your specific needs.

For further information, contact your local Ramtite representative.

Ramtite Is Our Business, Not a Side Line

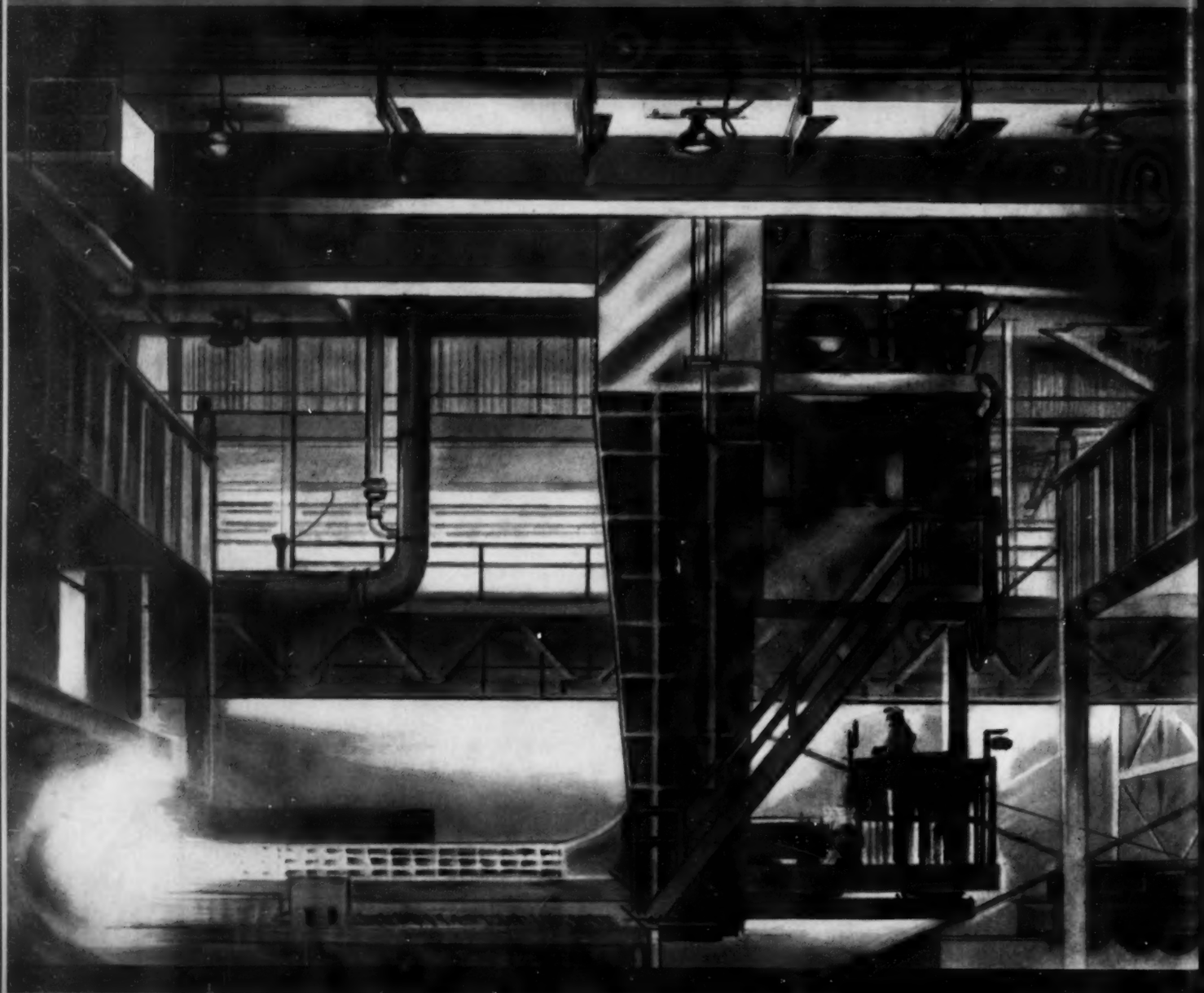
The Ramtite Co.

DIV. OF THE S. OBERMAYER CO.
1813 South Rockwell Street
Chicago 8, Illinois

© 1957

This is another in a series of advertisements depicting ways Ramtite Refractories serve the Steel Industry.

CRANE-TYPE SLAB CHARGING MACHINE



Alliance

"Give us the Runway and we'll lift the World"

This 20-ton crane-type slab charging machine is equipped with end grip tongs. There are no tracks on the floor to hinder movement of wheeled equipment. The peel and mast are arranged for 360° rotation. Peel raises and lowers in horizontal position at all times. The operator's position, with reference to the peel and slabs he is handling, is fixed. His vision is unobstructed. This is one of many safety-engineered Alliance heavy-duty handling devices. For practical, economical solutions to your materials handling problems consult the Alliance engineers. They'll work with you to create the one device that meets your needs best.

THE ALLIANCE MACHINE COMPANY • MAIN OFFICE • ALLIANCE, OHIO

LADLE CRANES · GANTRY CRANES · FORGING MANIPULATORS · SOAKING PIT CRANES · STRIPPER CRANES · SLAB AND BILLET CHARGING MACHINES · OPEN HEARTH CHARGING MACHINES · SPECIAL MILL MACHINERY · STRUCTURAL FABRICATION · COKE PUSHERS

Equipment News...

MASTER SWITCH

▲ A complete line of a-c and d-c master switches is now available from the General Electric Co.

The company's Industry Control Department, Roanoke, Va., has added a heavy-duty under-desk master switch and completely redesigned its existing line which includes general-duty and heavy-duty surface-mounted models.

Both heavy-duty switches are designed primarily for steel mill, crane, and power shovel applications, while the general-duty model is best suited for small crane and conveyor applications.

The new heavy-duty under-desk unit is available in two pieces—the operating head and switching unit. This provides for greater mounting flexibility and simplified operation and stocking. Ranging in size from $8\frac{7}{16}$ x 5 x 3 in. to $16\frac{7}{16}$ x 5 x 3 in. for the switch unit and $3\frac{1}{4}$ x $4\frac{5}{8}$ x $7\frac{15}{16}$ in. for the head, it is believed to be the smallest heavy-duty under-desk switch available. Metal cam followers are utilized to provide longer life and reduced maintenance. Handle modifications include pistol grip, ball and rod with spring return, and ball and rod with either three-to-one or two-to-one gear boxes. A special free-standing model is also available. In addition, rheostats can be added to the switching device to provide stepless switching. Four, six, eight, and 12-circuit switch unit models are available with operating heads that have seven points in each direction.

The heavy-duty surface-mounted unit is lighter in weight and 25 per cent smaller than the previous GE model. Over-all dimensions are 8 x 8 x 11 in. This unit also makes use of metal cam followers instead of rollers to provide longer life and reduced maintenance. Optional features include a foot-operated mechanism, ball and rod handle with off position latch or auxiliary contact mechanism, a shaft extension for special operating arrangements, and an under-lever latch. Six and 12-circuit frame models are available.

The new general-duty surface-mounted switch utilizes bronze, oilless bushings for ease of operation, longer life, and reduced maintenance. This model ranges in size from $6\frac{9}{16}$ x $11\frac{1}{4}$ x 9 in. to $11\frac{1}{4}$ x 9 in. It is capable of 55-deg angular throw, five points in each direction. Ball and rod handles are available with off-position latch, auxiliary contact, or spring return. Six and 12-circuit frames are available.

All three master switches are rated continuously at 15 amps 600 volts a-c and have a d-c inductive rating of 1 amp at 250 volts d-c. Any desired contact sequence can be built into the units.

HYDRAULIC RAIL CLAMP

▲ The Wickwire Spencer Steel Division of The Colorado Fuel & Iron Corp. recently installed the most modern of safety devices on their stocking and reclaiming bridge at Buffalo, N.Y.

Hydraulic rail clamps developed, manufactured and installed by the Mead-Morrison Division of the McKiernan-Terry Corp. safeguard the stocking and reclaiming bridge at the Buffalo, N.Y., plant of The Wickwire Spencer Steel Division. The clamps prevent wind forces from moving the bridge along the dock rails.

Two double rail units were installed, one at each end of the bridge. The rail clamps automatically clamp the dock rails whenever the propelling master switch is placed in the "off" position or whenever the wind velocity exceeds 35 mphr. The clamping force is applied by a compression spring working directly on clamp jaws fitted with replaceable serrated shoes. The clamps are automatically released by a hydraulic system when the propelling master is placed in the "on" position. Designed to fail safe, any failure in the electrical or hydraulic systems will automatically set the clamps.

CONTOUR LATHE

▲ An electronically controlled contour roll lathe has been ordered by Inland Steel Co. for its Indiana Harbor Works from the Mackintosh-Hemphill Division of E. W. Bliss Co. The lathe, of nominal

A 60-in. electronically-controlled contouring lathe will join this 48-in. model at Inland Steel's Indiana Harbor Works. The lathe shown here has brought about major savings in turning shape and beam mill rolls because of its ability to cut passes automatically at high speed.

PENNY-WISE PETE

LOSES PIKE!

No "even keeled" fisherman would try to save a few cents by fitting his expensive rod and reel with a low quality line.

That's as foolhardy as "saving" on a refractory bonding mortar. Soundest economy is to buy the best.

On most installations, the difference in cost for using the best—SUPER #3000 REFRACTORY BONDING MORTAR—is actually NEGLIGIBLE. With Super #3000 you're guaranteed dependable trouble-free service worth hundreds or possibly thousands of dollars.

Super #3000 is the only refractory mortar which equals or even surpasses the strength, resistance to heat, erosion and abrasion of the best grades of refractory brick. Countless service reports prove it.

Write on your letterhead for a free trial drum of Super #3000, without obligation.

REFRACTORY & INSULATION CORP.

R&I

REFRACTORY BONDING AND CASTABLE CEMENTS
INSULATING BLOCK, BLANKETS AND CEMENTS

136 WALL STREET NEW YORK 5, N. Y.

60 in. swing and 25 ft between centers, will have an electronic follower control mechanism so sensitive that it can duplicate the contours of a master template within 0.001 in.

Inland will use the lathe for dressing back-up rolls and turning structural rolls. It will incorporate a number of special design features to speed set-ups and changeovers, and to provide the extra power needed to turn up to 75-ton rolls.

It will be equipped with a power-traversed tailstock and power-traversed neck housings having hydraulic locking clamps. Moreover, its main motor will be rated at 150 hp, sufficient to provide a speed range from 0.17 rpm to 62 rpm through the heaviest depths of cut.

TRANSFORMERS

▲ Westinghouse Electric Corp., has announced that two lines of dry-type distribution transformers (Types DS-3 and DT-3) have been extended to include lower ratings with decreased weight and size.

The three-phase DT-3 model is now available in a 30-kva rating, extending the line to ratings from 30 to 300 kva in either 600- or 2400-volt class. The new model is 22 per cent smaller than the previous similarly rated design, and 20 per cent lighter.

The single-phase DS-3 model line now includes a low rating of 15 kva, making the range of ratings from 15 to 167 kva in the 600- and 5000-volt classes. This new model is 15 per cent smaller and 20 per cent lighter than the previous design of similar rating.

Construction and all design characteristics of these new transformers are the same as those already in use at larger ratings, featuring mechanically isolated core and coils to provide very low sound levels.

FURNACE FRAMES—DOORS

▲ A new line of open hearth frames and doors has been developed by the Hutton Fabricating Mfg. Corp. This equipment is reported to result in up to 32 per cent longer life due to its new water-cooling and refractory lining features.

Uniquely designed frames permit concentration of water at the critical burnout points, particularly at

Why should you pay

for top quality in "Commercial Grade" Roller Bearings . . . AND NOT GET IT?

It's *wasteful* to pay for quality you don't need. It's *negligent* to pay for quality you don't get.

From the simplest steel-cage type to the finest segmented-retainer type, Rollway "commercial grade" Tru-Rol Roller Bearings incorporate as closely as possible design and construction principles found normally in a Rollway maximum-type precision bearing.

Take the segmented-type Tru-Rol for example. Each deep-section separator segment is formed to fit the curvature of the roller. Each roller has a separator segment to keep it in accurate alignment. And each roller is crowned to distribute load evenly along the full length of the roller.

That's a lot different from small-diameter, unground spacers staggered at unequal intervals, resulting in rollers rubbing in opposed-motion, and non-uniform roller distribution that can set up out-of-balance vibration and "pulse".

Let a near-by Rollway Service Engineer consult with you on your bearing problems. No charge. No obligation. Just write us. Rollway Bearing Co., Inc., Syracuse, N. Y., *manufacturers of a complete line of radial and thrust cylindrical roller bearings.*

Cutaway view of Rollway Tru-Rol® segmented-retainer roller bearing . . one of three distinct types of Tru-Rol bearings available.

ENGINEERING OFFICES: SYRACUSE • BOSTON • CHICAGO • DETROIT • TORONTO • PITTSBURGH • CLEVELAND • MILWAUKEE • SEATTLE • HOUSTON • PHILADELPHIA • LOS ANGELES • SAN FRANCISCO

Check This List AND BE SURE!

Retainer Operation

☐ Is the retainer roller-supported, to reduce sliding friction?

Retainer Construction

☐ Is the retainer strong enough to withstand shock loads and sudden reversals?

(A Rollway segmented-type steel retainer, such as that illustrated, is the strongest, most durable available in commercial grade bearings.)

Roller Spacing

☐ Are all rollers equally separated, or do some rub against each other in opposed-motion friction?

☐ Are rollers distributed evenly to prevent "pulse" and vibration?

Roller Construction

☐ Are the rollers crowned for optimum load distribution?

For Top Quality in Every Detail Buy Tru-Rol and Be Sure!

the 9-in. arch areas. Door guides are also water-cooled. Arch-type frames have twin arches to give added strength.

The doors, also water-cooled, have a new type refractory area design. Studs are used to hold the refractory material in place, which permits a deeper refractory lining. The studs burn down with the refractory material and are easily renewed when a new lining is inset in the door.

Doors and frames are made of special low carbon steel. Frames are made with or without arches.

PORTABLE TESTING UNIT

▲ A completely portable, battery-operated ultrasonic thickness measuring unit has recently been perfected by Magnaflux Corp. The Sonizon SO-200 locates areas of corrosion or wear on storage tanks, pipes, ship hulls, airplane wing skins, drier rolls, and other structures and products accessible from one side only. During manufacture, too, thickness is easily measured, and laminations and lack of bond between materials can also be detected.

With an entirely new means for reading ultrasonic thickness measure, the unit is fast, positive and simple to operate. In effect, it gives direct readings of thickness. The operator selects the proper crystal range, places the probe on the test area, and rotates the circular read-out dial until the harmonic lines match a pattern of flashing lights. He then reads thickness directly from the dial.

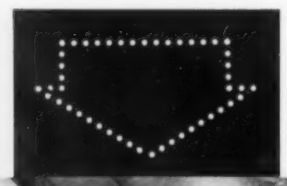
In operation, the unit is carried by means of shoulder straps. The read-out dial faces upward for convenient reading. The battery case, joined to the main unit by a connecting cable, is also carried by shoulder straps.

Battery-operated portable unit in use, with curved crystal probe, during test of thickness of piping, in place. Test is similarly made on any tank or vessel, casting or part, where metal thickness is in question, either during manufacture or overhaul, indoors or outdoors.

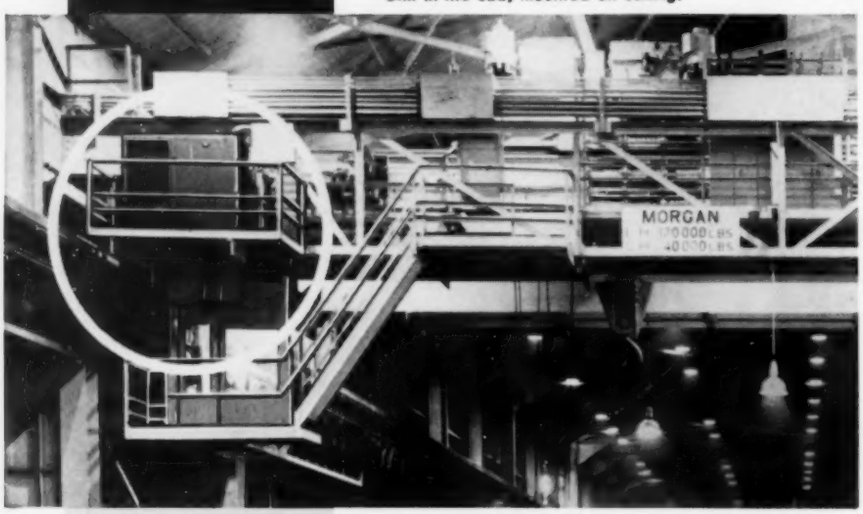
The SO-200 requires no warm-up time. It measures with an accuracy of ±3 per cent on thicknesses between 0.027 in. and 4 in., and works on practically all materials which will transmit ultrasonic sound. These are the rigid materials, including most metals, glass, hard insulators, etc.

WELDING BLOWPIPE

▲ The Oxweld W-47 Blowpipe, a new medium-pressure welding blowpipe capable of welding any metal



Model 527 AC-7.5 Lintern Aire-Rectifier installed on a Morgan crane operating in the annealing department of the tin mill plant at the Weirton Steel Division of the National Steel Corporation, Weirton, West Virginia. Note condenser on platform attached to footwalk. It is connected by refrigerant lines to the Cooling Unit in the cab, mounted on ceiling.



• • • *achieving Full Use of*

CAPITAL EQUIPMENT

by **LINTERN** AIR CONDITIONING

By air conditioning crane cabs and pulpits, plants are making the most of profit opportunities — achieving full use of costly equipment and getting the most return on capital investment.

Lintern Aire-Rectifiers are made in a range to meet all conditions — from 90°-230° F. More than one thousand are in daily service on practically every type of crane and pulpit operation in steel, aluminum, copper, and other industrial plants, wherever excessive heat, dust, gas and fume conditions are prevalent.

ASK FOR BULLETIN AC-573.

Larco, inc.
DISTRIBUTOR OF LINTERN CORPORATION PRODUCTS
ROUTE 20, EAST • PAINESVILLE, OHIO

Treadwell

Courtesy Jones & Laughlin Steel Corp

Bar and billet mill cooling beds capable of handling up to and including 5" square bars or billets up to and including 35" in length.

Beds are approximately 120" in length overall.

Bars or billets can be deposited on the beds alternately as fast as they are delivered from the mill.

BETTER GRADE MACHINERY

Treadwell Engineering Company

EASTON, PA.

SALES AND ENGINEERING OFFICES:

208 S. LA SALLE STREET CHICAGO 4, ILL. CEntral 6-9784	140 CEDAR STREET NEW YORK 6, N. Y. WOrth 4-3344	1015 FARMERS BANK BLDG. PITTSBURGH 22, PA. ATlantic 1-2883

thickness from 28 gage to 3 in. and handling heating jobs requiring total gas flows up to 1500 cu ft per hr, has been introduced by Linde Co., Division of Union Carbide Corp.

The new W-47 handles any oxygen or acetylene flow from 2 to 300 cu ft per hr. Fuel gas heating heads are available for use with total gas flows as high as 1500 cu ft per hour. A simple change of welding heads quickly converts the blowpipe from light-duty welding and brazing to heavy-duty welding or heating. This feature enables the W-47 to handle a range of work normally requiring two or more blowpipes. A convenient cutting attachment equips the blowpipe for flame-cutting on metal up to 8 in. thick.

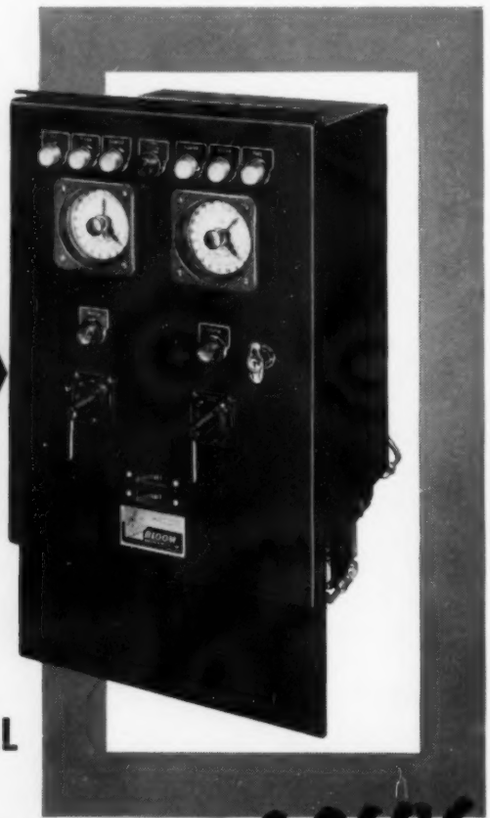
Each of the 42 welding and heating heads available for use with the new unit has an individual cartridge-type mixer that provides thorough mixing and proportioning of gas, thus assuring soft and stable welding flames. Flashback is prevented at all working pressures. Stainless steel, used extensively for strength and durability, retards heat conduction to the handle and internal parts even after hours of continuous use. Chrome-plated welding heads resist the adherence of slag and spatter.

Individual mixers in each welding head make it possible to weld metal up to $\frac{3}{4}$-in. thick using only five lb of oxygen and acetylene pressure. Both regulators can be set at this single pressure regardless of the size welding head used.

Fast welding head changes plus leak-proof operation are made possible with the W-47's new spring-type coupling nut and "O" ring gas seals. Valves are self-seating. Turning the valve wheels down tight automatically reseats worn seats, thus assuring maintenance-free operation.

A full selection of welding and heating heads, including multiflame heating heads for acetylene and other fuel gases, is available for use with the new blowpipe. In addition, a wide variety of heads, extensions, and accessories for flame-priming and descaling work is also available.

The BLOOM Time-Cycle Reversal Unit



assures FULL, FAST AND EFFICIENT REVERSAL OF REGENERATIVE FURNACES AUTOMATICALLY

This complete, compact, factory-tested unit provides a combination electric-pneumatic system for Open Hearth Furnace and Soaking Pit reversal. It elimnates reversal puffing and shortens reversal period. (10 to 15 seconds easily accomplished).

Shorter reversal cycle improves furnace life.

These units have been in continuous service for nine years. Trouble-free maintenance.

BLOOM ENGINEERING CO., INC.
857 W. North Avenue Pittsburgh 33, Pa.

WRITE or phone for complete information on the Bloom Time-Cycle Reversal Unit.

TEEMING LADLE

▲ A new, lightweight steel teeming ladle, designed and built by Pennsylvania Engineering Corp., will carry an additional 15 tons of molten metal yet weighs 16,000 lb less than conventional ladles. The example illustrated was built for a major steel producer and is performing successfully, carrying 150 tons of metal with a shell weight 16,000 lb lighter than the conventional 135-ton ladle.

This is accomplished by engineering design improvements only—without reduction of strength or the use of alloys. Outstanding features of the new ladle are: heavy box-section bands and shell stiffeners for highest strength-to-weight ratio, cast segmented combination brick ring and top stiffener for convenient maintenance, a heavy dished

bottom riveted to shell for easy service, and a payload-to-shell weight ratio of almost 8 to 1 instead of the usual 5- or 6-to-1.

GEAR MOTORS

▲ Announced by the General Electric Co.'s Gear Motor and Transmission Components Department is a new line of integral horsepower gear motors and related transmissions.

The new line will be offered in three basic components: an integral-type unit, functionally equivalent to previous GE designs where gear and drive motor are packaged into a single unit; an all-motor type which features the drive motor coupled to the gear reducer and mounted on a common carrier; and a separate helical speed reducer which may be used with a variety of prime movers.

Mounting dimensions on all three components are identical for similar rating and parts are interchangeable, permitting the user, maximum stock flexibility in backup parts and units.

Constructed in the double helical gear design, the new line has been engineered to take advantage of the latest technological advances in gear manufacture. The design is compact, flexible in application, and offers ease of maintenance.

Another new feature is a built-in provision for accomplishing ratio changes through a change of pinion and gear in the first stage only. This added flexibility will permit the user to provide for changing demands in production rates without costly investment in additional inventory. Means for removing and replacing the pinion and gear are designed into each unit as captive assemblies.

The flexibility of mounting arrangement enables the user to cover a broad range of mounting requirements without factory alteration. Permissible mounting planes have been extended and additional provision for field adaptation to extreme positions is available in a simple oil level kit.

Gear and bearing alignments are machined into the new line, permitting maintenance disassembly and reassembly without loss of alignment. The gear housing is completely accessible from either end, thus facilitating inspection or disassembly. Gear components can be carried in stock as sub-assemblies minimizing downtime for normal repairs.

The line will be offered in three basic types of speed reductions: single reduction offset shaft in speed ranges from 780 to 350 rpm; double reduction concentric shaft for speeds from 350 to 37 rpm; and triple reduction concentric shaft for output speeds from 30 to 13.5 rpm.

Integral-type gear-motors will be available in the new line from one to 30 hp. The first ratings, up to 10 hp., will be released on October 1. The line will be completed through 30 horsepower by February 1, 1958.

Separate helical speed reducers and all-motor gear motors will be developed from one to 75 hp by July of 1958. The release of the initial sizes will coincide with the release of the corresponding gear motor ratings.

EXTRUSION STRETCHER

▲ The development of a range of high-production hydraulic stretching and detwisting machines for straightening both ferrous and nonferrous metal sections has been announced by Loma Machine Manufacturing Co., Inc.

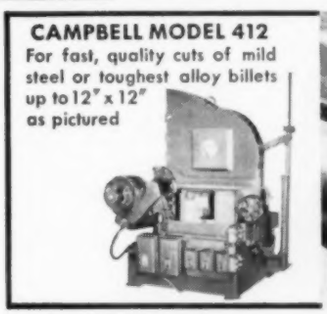
Available in sizes up to 200 tons, the stretchers have been designed to

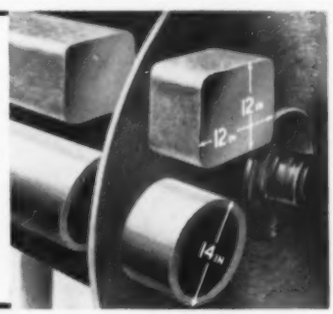
Campbell
Abrasive Cutting Machines

Abrasive Cutting Know-How

Know-How is just as vital to top performance in abrasive cutting as in any other machine tool operation

CAMPBELL MODEL 412
For fast, quality cuts of mild steel or toughest alloy billets up to 12" x 12" as pictured





Users of Campbell Abrasive Cutting Machines get Tremendous Savings with Fast, Accurate, Quality Cuts of Mild Steel or Toughest Alloys

Write us and we will gladly send you helpful information on the working capacities of the 16 models of CAMPBELL Machines and the CAMPBELL Operating Features that explain the outstanding performance of these machines in cutting a wide variety of shapes and sizes of stock—channels...bars and tubing from the smallest to 14" diameter ...plate up to 4" thick and 20 feet long ...billets up to 12" x 12".

CAMPBELL Machine performance is well illustrated by the **Model 412** pictured above. This machine cuts through 12" x 12" billets of mild steel or toughest alloys (even titanium) in the almost unbelievable time of 6 to 10 seconds per square inch...*with quality cuts.*

Here are some of the operating features that account for comparable speed and quality of cuts by CAMPBELL's 10 high speed production models...two of them fully automatic for highest production.

Oscillation of the Cutting Wheel to maintain cutting speeds and greatly lengthen wheel life is prescribed by CAMPBELL for all solids cuts over 2" in diameter.

Wet Cutting gives maximum assurance of Quality Cuts.

Ample Power, essential to good performance, is supplied for the Model 412 by a 40 HP motor.

Sound Work Holders — essential to accuracy.

For greatest abrasive cutting accuracy, CAMPBELL provides two oscillating machines that rotate the work—round bars or tubing from 3" to 14" diameter.

For further information write for the illustrated Bulletin DH-460-B

ACCO

Campbell Machine Division • AMERICAN CHAIN & CABLE

928 Connecticut Avenue, Bridgeport 2, Connecticut

SYNTRON

BIN VIBRATORS

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for the basic Steel Industry

...dependability with top performance to handle increased production requirements

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Investigate how Syntron Equipment can help increase production and lower operation and maintenance costs.

Syntron's years of experience in the materials handling field are available to you. Send details of your problems to our application engineers for recommendations.

Builders of quality equipment for more than a Quarter-Century

Write for complete catalog data — FREE

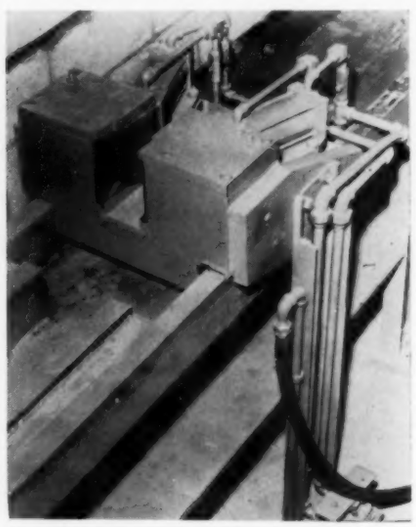
SYNTRON COMPANY
699 Lexington Avenue Homer City, Penna.

handle extruded or rolled bars, tubes, structural shapes or sheet and strip. Individual lengths from 4 ft to 100 ft or more can be stretcher-levelled on these machines at high production rates.

Outstanding feature of the new stretchers is their optional availability with a special open tailstock, designed to allow the stock to protrude past the gripping jaws. When using this special head, extrusions of varying lengths may be gripped and stretched without moving the tailstock every time or trimming the extrusions to uniform length.

The new arrangement allows extremely fast loading and unloading of the machine and also facilitates detwisting of shapes over only part of their total length. In such cases the tailstock is simply advanced toward the headstock until only the twisted portion of the extrusion is gripped, the remainder being allowed to protrude through the tailstock.

The stretchers are completely self-contained machines having their

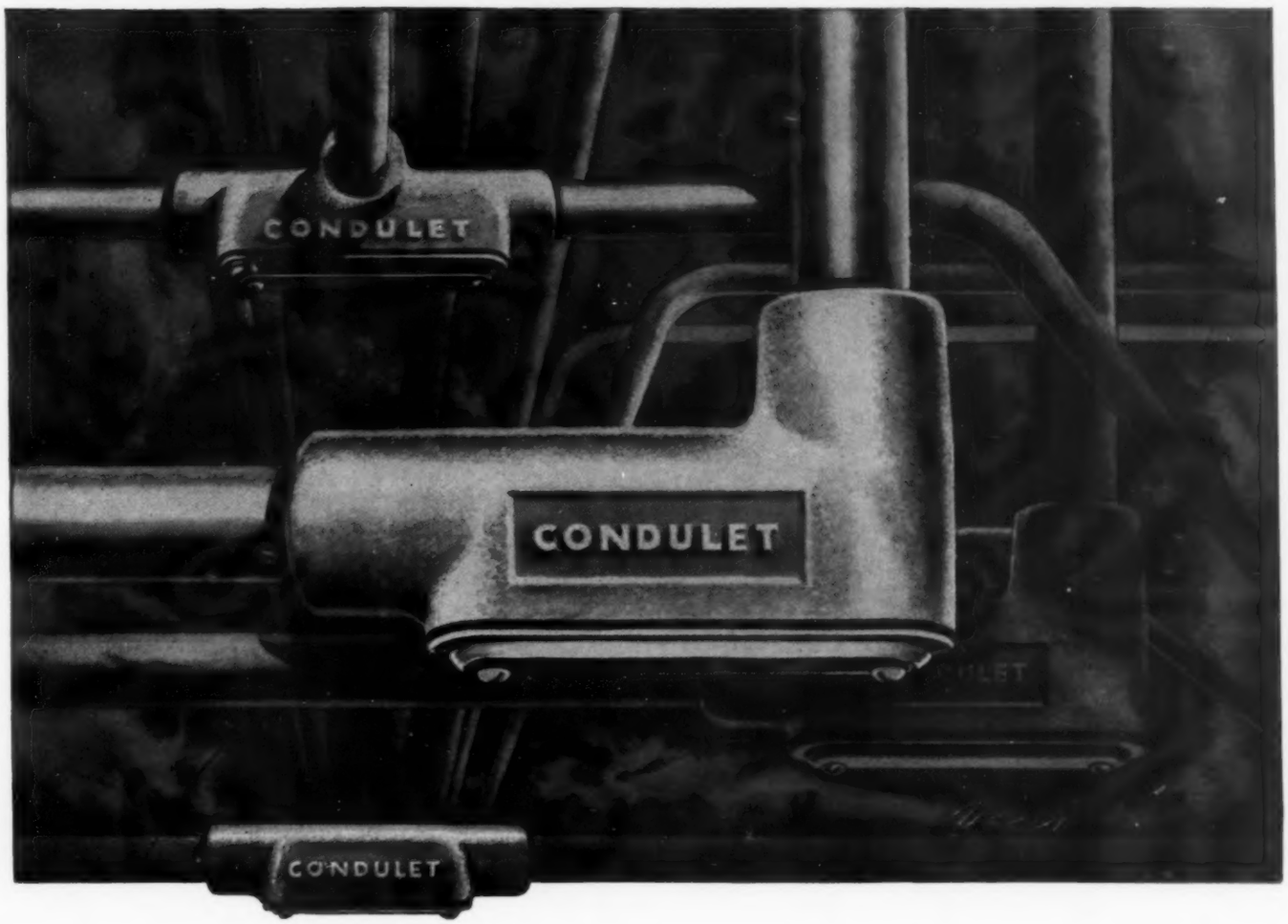


Special open tailstock of stretcher is designed to allow stock to protrude past the gripping jaws.

oil-hydraulic power units conveniently mounted above the stretching cylinder. To facilitate rapid setup for varying lengths, the tailstock has power travel, and its anchoring pins are engaged or withdrawn by an air cylinder. The gripping jaws in both the headstock and tailstock are moved by air cylinders and controlled by conveniently mounted foot-operated valves, which leave the operator's hands free to handle the stock. The detwisting motion is applied to the headstock by a brake-

Nothing Beats

CONDULETS* and RIGID CONDUIT for FLEXIBILITY, SAFETY, ECONOMY



- **INSTALL ANYWHERE.** Crouse-Hinds Condulets and rigid conduit operate safely and efficiently under all atmospheric conditions and in all occupancies.
- **INCREASE CAPACITY EASILY.** You don't have to tear out and replace the entire system: merely pull additional wires or put in a larger size.
- **ASSURES MAXIMUM SAFETY.** Condulets are Taper-Threaded to provide a permanent low resistance path to ground.
- **GREATER DURABILITY.** Condulets and rigid conduit provide circuits with more protection against physical damage than any other wiring system. Further, Condulets are made of galvanized cast Feraloy, and resist corrosion.
- **LOWER OVER-ALL COST.** First cost is the entire cost — a minimum of maintenance is required.

COMPLETE FLEXIBILITY

There's a Condulet to meet every need of complex modern electrical layouts. See your Condulet Catalog.

A NATIONWIDE DISTRIBUTION exclusively through ELECTRICAL DISTRIBUTORS

*CONDULET is a coined word registered in the U.S. Patent Office. It designates a product made only by the Crouse-Hinds Company.

CROUSE-HINDS COMPANY

Main Office and Factory: Syracuse, N. Y.
Crouse-Hinds Company of Canada, Ltd.: Toronto, Ont.

OFFICES: Birmingham Boston Buffalo Chicago Cincinnati Cleveland Dallas Denver Detroit Houston Indianapolis Kansas City Los Angeles Milwaukee New Orleans New York Philadelphia Pittsburgh Portland, Ore. St. Louis St. Paul San Francisco Seattle Tulsa Washington RESIDENT REPRESENTATIVES: Albany Atlanta Baltimore Baton Rouge Charlotte Chattanooga Corpus Christi Jacksonville Reading, Pa. Richmond, Va. Shreveport

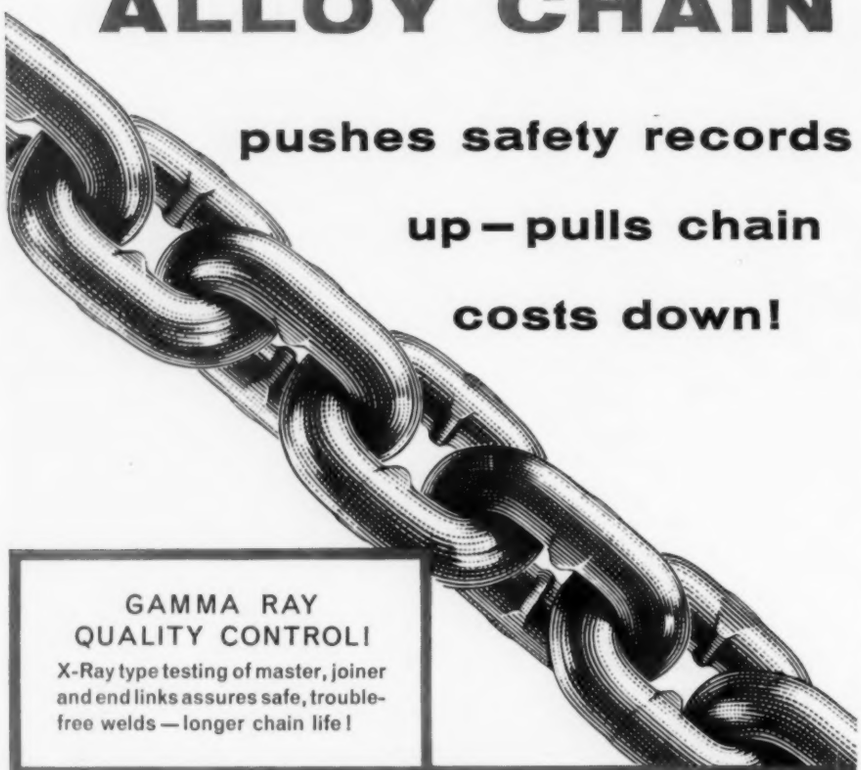
TM Triple-Safe

ALLOY CHAIN

pushes safety records

up—pulls chain

costs down!



GAMMA RAY QUALITY CONTROL!

X-Ray type testing of master, joiner and end links assures safe, trouble-free welds—longer chain life!

CONTROLLED ATMOSPHERE HEAT-TREATING

on all popular alloy chain sizes provides uniformity throughout the sling assembly.

EXCLUSIVE PATENTED TAYCO HOOKS!

I-Beam type design . . . alloy steel construction and unique recessed grip mean extra safety!

REGISTERED! You get a certificate of test with every TM Alloy Chain. It bears the chain's guarantee . . . proof test . . . serial number.

You alleviate the squeeze on profits and tighten your grip on safety when you switch to TM Alloy Steel Chain. Gamma Ray Quality Control . . . Controlled Atmosphere Heat-Treating . . . new patented Tayco Hooks make it *Triple-Safe*—last many times longer than low-carbon steel chain. Never requires annealing! Tough—withstands abrasion, shock, grain-growth and work-hardness. Get *all* the facts! Write for Bulletin 13 right away!

Chain is our specialty, not our sideline!

TAYLOR MADE A GREAT NAME IN Chain SINCE 1873

S. G. TAYLOR CHAIN CO., INC.
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Eastern Plant—Pittsburgh, Pa.

motor driving through worm gearing, with rotation being unlimited in both directions.

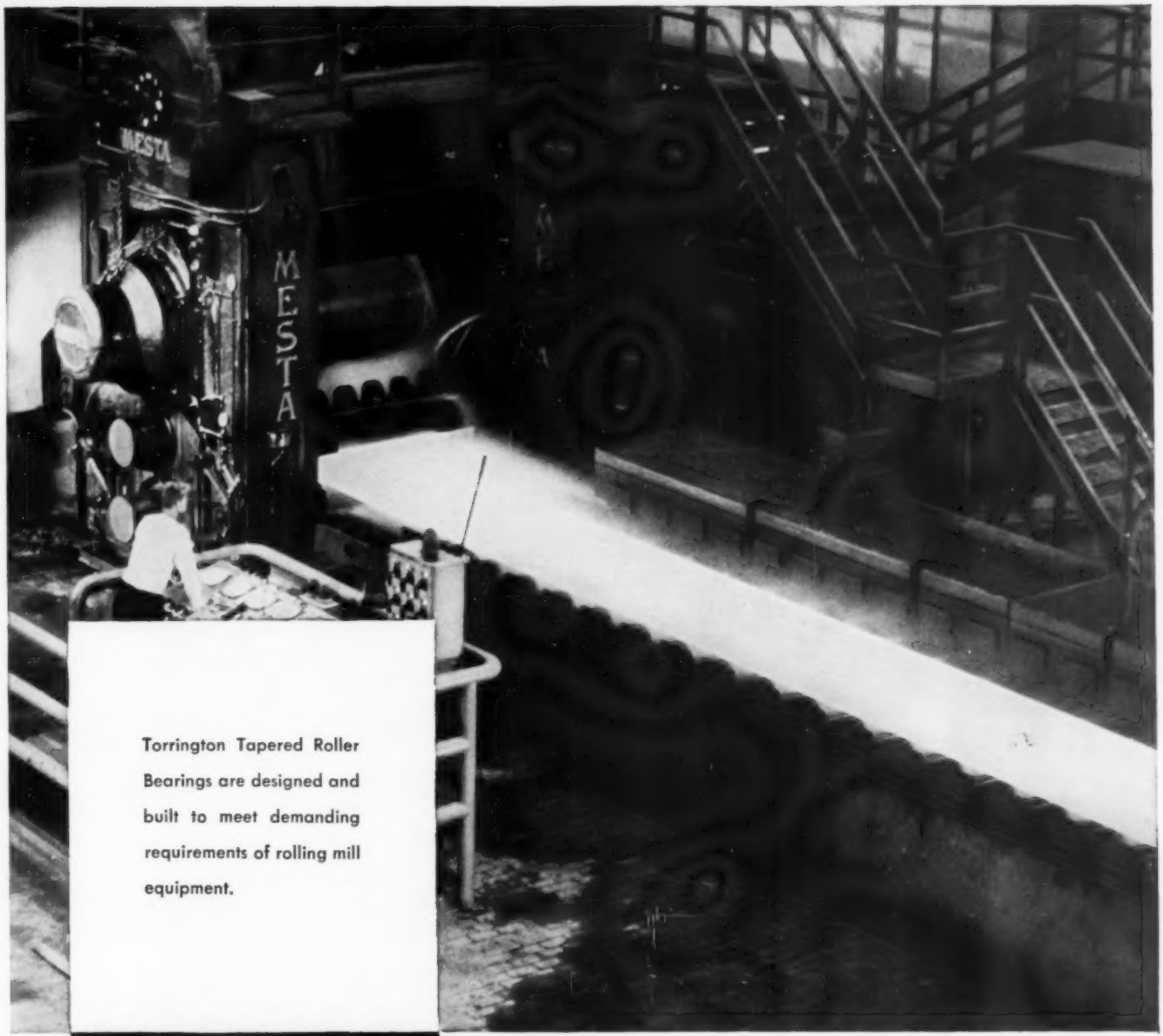
The headstock, which performs the stretching movement, is connected to the stretching cylinder by long tie bars and a cross-head attached to the end of the piston rod. The latter is of extra large diameter so that the displacement at the piston rod end of the cylinder is greatly reduced. This design affords most favorable operating conditions: the full cylinder area becomes available for the generation of the stretching force, while for the movements in opposite direction high return speeds are automatically produced. The tie bars are supported by shoes sliding on machined ways of the frame, thereby eliminating any possible deflection of the piston rod. The cylinder, thus, is protected against undue wear and requires very little maintenance during long operational periods.

The oil-hydraulic power unit for the operation of the stretching cylinder comprises two pumps—one low-pressure pump of large volume capacity, and one high-pressure pump of small output. During the cylinder movement involving small forces—take-up movement and idle return—both pumps supply oil to the cylinder for fast travel. As soon as pressure builds up in the cylinder at the start of the stretching process beyond a preset level, the low-pressure pump is idled and the high-pressure pump only operates. Whenever stock of relatively small section is to be processed, both pumps may remain engaged even during the stretching operation, to increase the output of the installation.

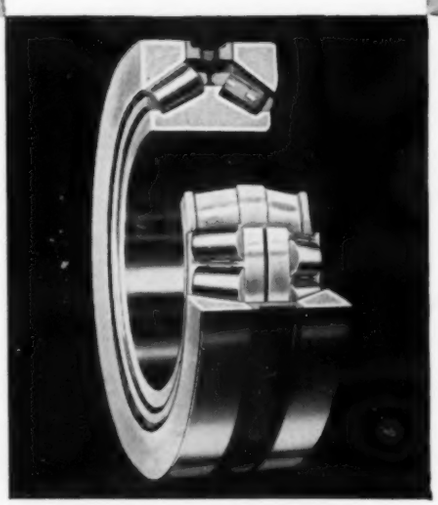
FLEXIBLE COUPLINGS

▲A new line of flexible couplings taper-bored for use with "QD" taper bushings has been announced by Lovejoy Flexible Coupling Co. Six different sizes range from 22 to 150 hp at 1750 rpm. Stock bushing bore sizes begin at $^1/_2$ in. and progress to $3^1/_2$ in. by $^1/_{16}$ in. The couplings will accommodate standard "QD" bushings, including types SD, SK, SFG and CE.

These couplings have been adapted to taper bushings to provide three important advantages: (1) reduction of normal stock requirements of coupling bodies; (2) immediate availability of a wide range



Torrington Tapered Roller Bearings are designed and built to meet demanding requirements of rolling mill equipment.



Meeting Production Demands!

Today's heavy production demands on modern continuous hot and cold strip mills put back-up roll thrust bearings to severe test.

That's why you find so many Torrington Two-Row Tapered Roller Bearings in this service throughout the country. Operators have learned that they can rely on Torrington Bearings to roll out record tonnages with only routine maintenance.

Little wonder—steep-angle design gives them capacity to spare for handling heavy thrust loads. Only highest quality electric furnace, alloy-bearing steel is used, carburized and heat-treated for toughness, hardness, stability and uniformity. Precision workmanship assures even load distribution and minimum friction.

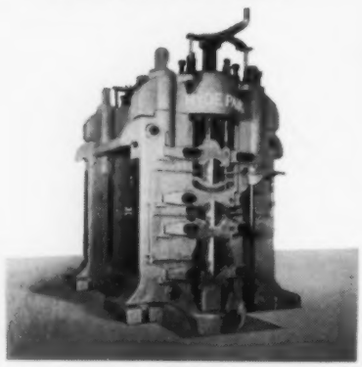
Torrington Two-Row Tapered Roller Bearings are available with either pin-type or cast-bronze, land-riding cages. Like Torrington Four-Row Tapered Roller Bearings and Spherical Roller Bearings, they offer performance you can rely on when production schedules demand the best. **The Torrington Company, South Bend 21, Ind.—and Torrington, Conn.**

TORRINGTON BEARINGS

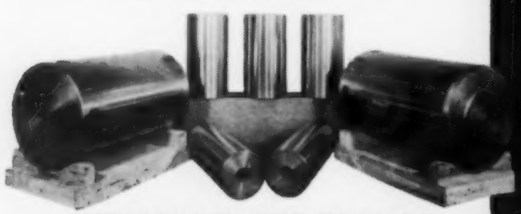
District Offices and Distributors in Principal Cities of United States and Canada

TAPERED ROLLER • SPHERICAL ROLLER • CYLINDRICAL ROLLER • NEEDLE • BALL • NEEDLE ROLLERS • THRUST

STRETCHER LEVELLER



18" 3 Hi BAR MILL



CHILLED IRON HYDRAULIC RAMS

MACHINE TOOL
BASE PLATE

Rolls and Rolling Mill Equipment...

For over half a century Hyde Park has built only the best. The name HYDE PARK on a Roll or on a piece of Rolling Mill Equipment is our guarantee of quality, and your assurance of high performance. Our engineers will be glad to work with you on any special roll or rolling mill equipment.

A "RED CIRCLE" ROLL FOR EVERY PURPOSE

Alloy Iron Rolls . . Grain Rolls . . Chilled Rolls . . Nickel Chilled Rolls . . Moly Rolls . . Cold Rolls . . Sand Rolls.

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Bar Mills • Merchant Mills • Sheet and Strip Mills • Pinion Stands • Roller Tables • Reduction Drives • Stretcher Levellers • Guillotine Shears • Sheet Mill Shears • Roll Lathes • Special Machinery • Machine Work

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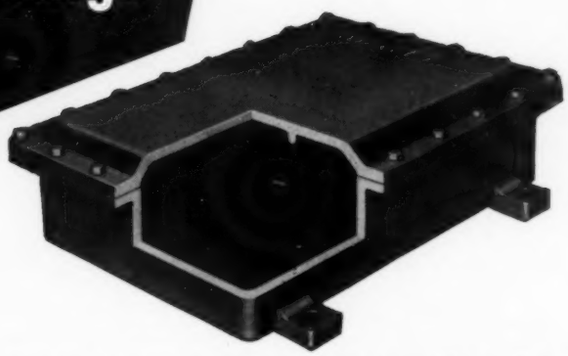
RED CIRCLE Rolls ALLOY-CHILLED

Hyde Park

FOUNDRY & MACHINE CO.

HYDE PARK, WESTMORELAND COUNTY, PITTSBURGH DISTRICT, PA.

Explosion-proof Housings cast aluminum



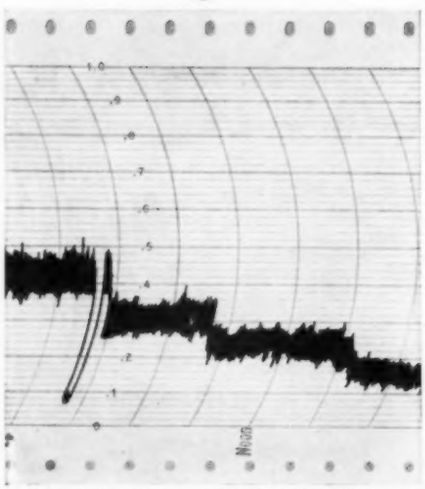
Non-sparking cast aluminum, strong and rustless. Available in a wide range of standard and special sizes.

Lightweight, easily mounts onto equipment. Drilled and tapped to specifications. Made to Underwriters and Military Specifications.

Send for Bulletin F

THE Adalet MANUFACTURING COMPANY
14300 LORAIN AVENUE • CLEVELAND 11, OHIO

RECORDERS WORK... *WHILE YOU ARE BUSY ELSEWHERE*



Courtesy Nuclear Measurements Corp., Indianapolis, Indiana

This record was made by a DC Milliammeter in a monitoring unit, measuring fall-out over Indianapolis after the explosion of an experimental bomb.

The recorder was on the job continuously for 1½ days before fall-out began to increase as shown here. Meanwhile the technicians and engineers were busy at other tasks.

Make recording instruments help you multiply your effectiveness. Ask for Catalog 657.

Product Representatives in Most Principal Cities

The ESTERLINE-ANGUS Company, Inc.
Pioneers in the Manufacture of Graphic Instruments
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of shaft sizes from this reduced stock by means of a convenient complimentary stock of "QD" bushings; and (3) a coupling-bushing combination that affords easy fastening to the shaft with the firmness of a shrunk-on fit.

MOTORS

▲Unusually sturdy electric motors designed to scorn some of their usual virtues are being produced by Westinghouse Electric Corp.

These motors are being made in one-fourth and one-horsepower sizes by Westinghouse for the Southwestern Engineering Co., Los Angeles, manufacturers of the Sweco "Vibrating Screen Separators" used for screening and separating.

In operation, the separators receive material on vibrating screens of the desired mesh. Depending upon the specific job, desired or unwanted parts of materials may be retained on the shaking screens or passed through the fine mesh.

To effect the shaking and tumbling motions necessary for screening and separating jobs, eccentric weights are attached to both ends of the shaft extending through the motor, which is mounted directly below the screen. Location and mass of these weights determines direction and degree of the motions imparted to the screen. Spring mountings prevent vibration of the motor-screen assembly from being transferred to the separator base, hence to the room or building in which the machine is used.

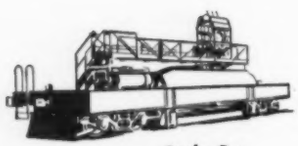
Book Reviews

"**Fogle's Engineer's Handbook**" has recently been published by William Fogle, 2412 N Beechwood Drive, mail address Box 2322, Station 28, Los Angeles 28, Calif. The book, with 8½ x 11 in. pages, is bound in heavy paper, and sells for $15. Book consists of data sheets with all the calculations, design and details worked out ready for the shop or field for fabrication, construction, and erection. Covered in the book are trapeze pipe hangers; concrete pipe sleepers; pipe anchors and supports, maximum length of pipe between supports; steel pipe saddles for large pipe; regulator valve hookups; steel pipe supports; welding details for branch pipe connections; cut backs for 2 through 24-in. pipe for angles between 5 and 50 degrees, in increments of 5

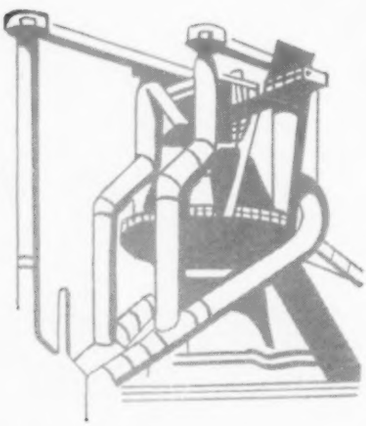
degrees; size of weld for branch pipe lines for header and branch sizes, 2 through 24 in.; insulation for steam traced lines; economical use of A-285 Gr-C or A-212 Gr-B steels; fabricated pipe steam separators; manhole cover davits and hinges; heavy column lifting lugs and separators for columns up to 250 tons; fireproofing for hot and cold columns; foundations for oil storage tanks; loads for checkered floor plates; tank car dimensions; truck and trailer dimensions and details of loading docks; maximum lengths for steel stacks for dead and wind loads 24 through 96 in. diam., 3/16-in. through 3/4-in. steel plate. The whole book consists of data sheet and tables, there is no text.

"Metal Statistics—1957" (50th edition) was compiled and recently published by the daily newspaper, American Metal Market, 18 Cliff St., New York 38, N. Y. The book contains 856 pages, 4 x 6 in., is cloth bound, and sells for $3.50. This book contains over 400 statistical tables covering production, deliveries, stocks, consumption, imports-exports, prices and other data on ferrous and non-ferrous metals. This 50th anniversary edition contains many new tables including custom smelter copper price changes, slab zinc deliveries to the United States government stockpile, end-use distribution of die castings, steel industry wage rates and major steel labor strikes. Comparative figures through 1956 are tabulated. A buyers directory of metals, metal products, ores and alloys is also contained in the volume.

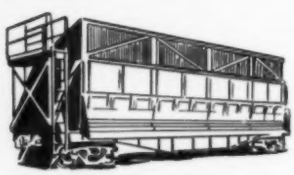
WHEREVER *performance* COUNTS



Scale Car



100-ton Ore Transfer Double Compartment, Bottom Dump



Coke Quenching Car

Atlas Cars are built to resist the high wear factors of continuous service handling abrasive materials. Extra factors of safety in brakes, controls, visibility, and signal devices are incorporated for foolproof service.

Each car is engineered to meet the operating needs of the plant where it will be used.

Consult Atlas for your Steel Plant Cars

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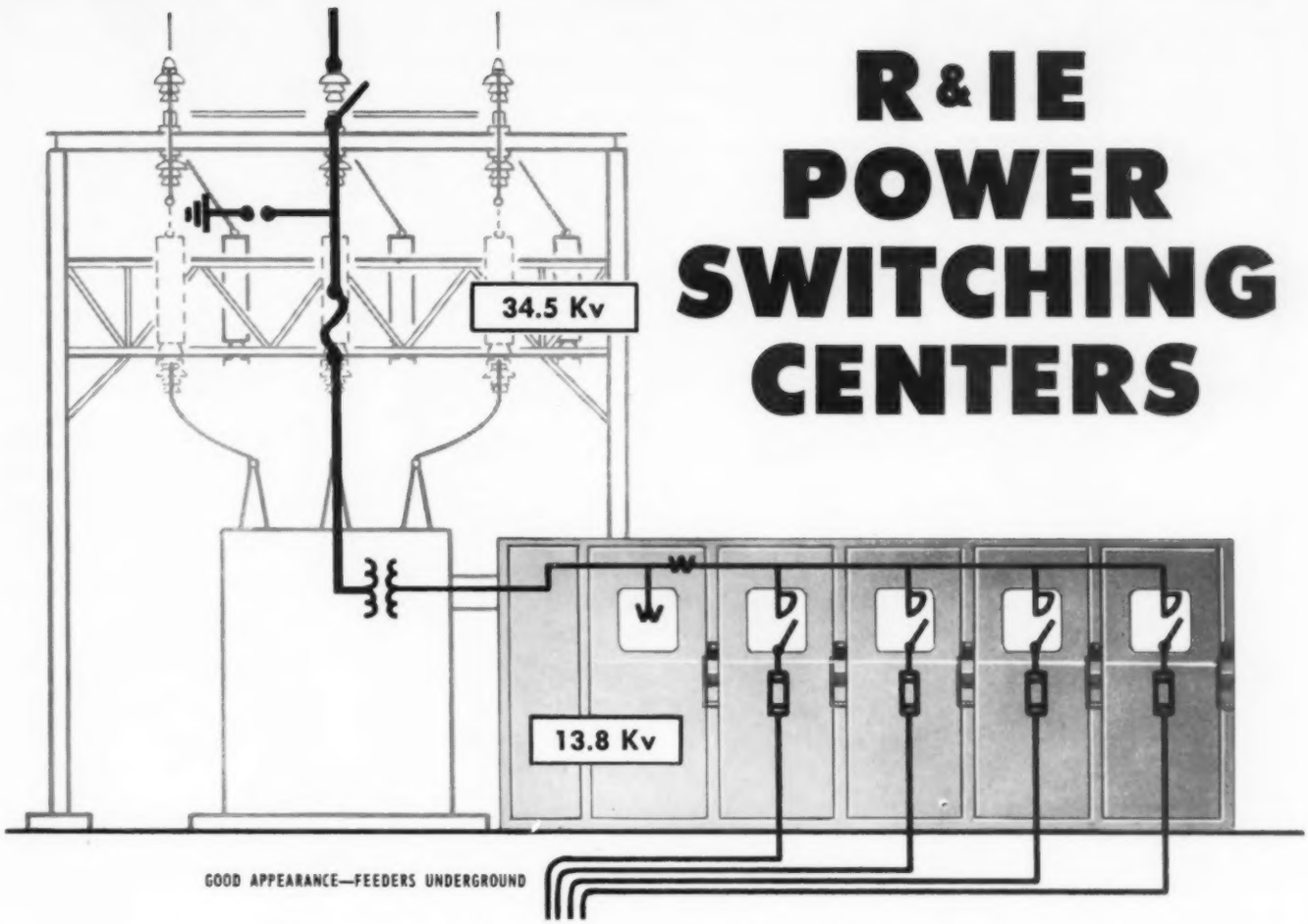
ENGINEERS AND MANUFACTURERS SINCE 1896

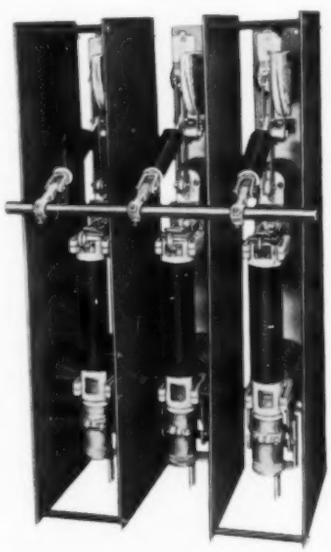
"Handbook Of Rigging" (second edition), by W. E. Rossnagel has recently been published by the McGraw-Hill Book Co., 327 West 41st St., New York 36, N. Y. The book contains 344 pages, 6 x 9 in., is cloth bound and sells for $6.50. This second edition is fully revised and up-to-date, and shows how to handle every step in any rigging operation, from rigging a swinging scaffold and painting a steel stack, to operating a hoist or using a hydraulic jack. Simple formulas used in calculating the strength of hoisting tackle, beams, posts, etc., are illustrated by a number of practical problems. Also given are such helpful items as data on safe loads on wire rope and chain, effect of defects on the strength of timbers, reference codes, laws, and standards relating to rigging, hoist signals, safety practice and first aid, and many other facts and data useful in aspects of planning and handling safe, effective rigging. The book also contains such material as information on the loading of heavy equipment on motor trucks and other transportation apparatus, methods of attaching sling to loads which are to be rotated onto their sides or completely inverted, new devices such as the Flemish eye splices for wire rope slings, new safety belt for use when climbing ladders on tall chimneys, new types of scaffolds, the "overland train" for transporting heavy loads through deserts, swamps and jungles. The text is written in plain, not-too-technical language. The many illustrations used contain special types of scaffolding and numerous newly developed kinds of equipment, including detail drawings for construction in plant shops where such equip-

R&IE POWER SWITCHING CENTERS



GOOD APPEARANCE—FEEDERS UNDERGROUND

Cost Less Save Space Easier to maintain



FUSED HPL-C INTERRUPTER SWITCHES

Ratings up to 14.4 Kv (110 BIL)
600 Amperes—(40,000 amps. momentary)
1200 Amperes—(60,000 amps. momentary)

HIGH VOLTAGE PSC CUBICLES, standard design—offer three-way economy for primary switching when space is limited, cost is a factor and where feeders are underground.

CONSERVE SPACE—Less area required than with open structure. Standard PSC cubicles mean space requirements can be accurately determined. Add a cubicle any time—up to 1200 amp. total load.

SAVE MONEY—R&IE fused interrupter switches, in PSC cubicles, provide a high degree of protection. High interrupting capacity at moderate cost.

REDUCE MAINTENANCE PROBLEMS—Easily operated; window front inspection; equipment accessible; universally-known power fuses. Can be handled by any factory or building maintenance crew.

Add safety with optional TOG-L SNAP operating mechanisms.

Ask your I-T-E Representative to show you the many economies of PSC cubicles.

R&IE EQUIPMENT DIVISION
I-T-E CIRCUIT BREAKER CO.
GREENSBURG, PA.

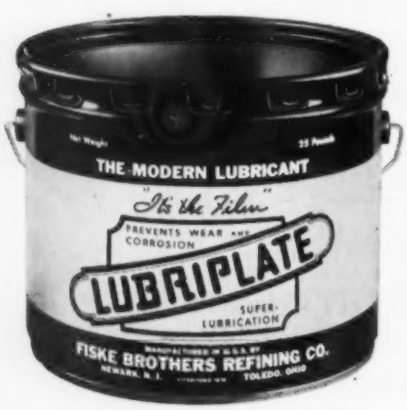
PSC - 4

LUBRIPLATE No. 630-AA LUBRICATES ABOUT EVERYTHING

LUBRIPLATE No. 630-AA is practically a universal grease type lubricant. It was developed to meet industries' need for *"simplified lubrication"* . . . one lubricant to effectively satisfy a great number of requirements. LUBRIPLATE No. 630-AA has a smooth, stable consistency, a wide temperature range, possesses high film strength, fine adhesive properties and is water repellent. It satisfies most lubrication requirements, thus eliminates the need for a different lubricant for each application in many cases.

REGARDLESS OF THE SIZE AND TYPE OF YOUR MACHINERY, LUBRIPLATE LUBRICANTS WILL IMPROVE ITS OPERATION AND REDUCE MAINTENANCE

For nearest LUBRIPLATE distributor see Classified Telephone Directory. Write for free "LUBRIPLATE DATA BOOK". . . a valuable treatise on lubrication. LUBRIPLATE DIVISION, Fiske Brothers Refining Company, Newark 5, N. J. or Toledo 5, Ohio.



ment, is not available on the market at this time.

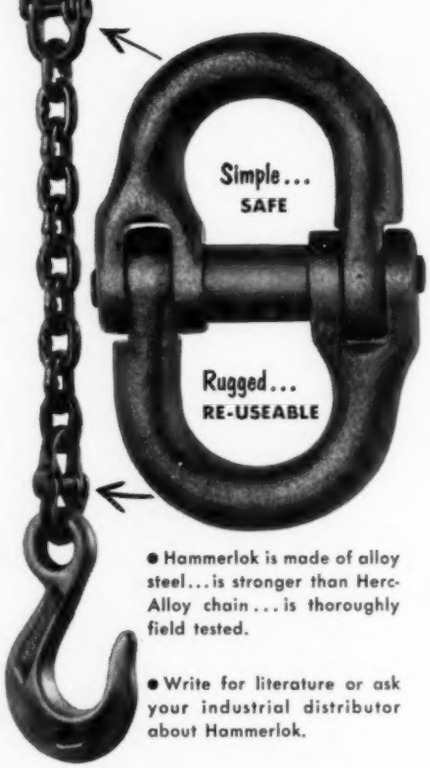
"Cast Metals Handbook" (fourth edition) has recently been published by the American Foundrymen's Society, Des Plaines, Ill. The book contains 316 pages, 8½ x 11 in., is cloth bound and sells for $10.00 but is available to AFS members at $7.00. This fourth edition was necessitated by industrial development, change and new product opportunities. The book contains reliable working data for utilizing the properties of cast metals to the greatest engineering advantages, unbiased and substantiated information on new developments in cast materials, practical up-to-the-minute facts on how to get the most out of casting designs. It is compiled specifically to enable the selection of the material best suited for a purpose, to supply needed information to facilitate cooperation between user and foundry, to obtain castings which best meet engineering requirements. The book is generously illustrated with photographs, tables, line drawings and charts.

"The Science of Engineering Materials," edited by J. E. Goldman, has recently been published by John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. The book contains 528 pages, 6 x 9 in., is cloth bound, and sells for $12.00. The book is the work of a number of the outstanding scientists in a variety of physical and engineering fields. To define the actual molecular makeup of materials, they explain and interpret, qualitatively, the properties of metals, alloys, semi-conductors, cements, polymers, and glasses. The contents is divided into six parts: the structure of matter—applications of solid-state science in engineering, structure of atoms and atomic aggregates, accomplishments and limitations of solid-state theory, crystal imperfections; metals and alloys—the metallic state, theory of some properties of metals and alloys, electron theory of alloy formation and elastic properties, dislocations in solids, dislocation theories of mechanical properties, experimental evidence for behavior of dislocations, phase transformations in metals and their influence on mechanical properties; surfaces—surface phe-

CM Hammerlok®
COUPLING LINK

Make your own HERC-ALLOY Chain Assemblies
with all components furnished from your distributor's stock.

NO PEENING NO WELDING



- Hammerlok is made of alloy steel... is stronger than Herc-Alloy chain... is thoroughly field tested.
- Write for literature or ask your industrial distributor about Hammerlok.

● MADE BY the makers of Herc-Alloy... the original alloy steel chain.

CM HOISTS AND CHAIN

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can be prevented by USG® BRUSHES . . .

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When a motor is out . . . you're money out. If you want to eliminate downtime caused by shunts jarring loose or being pulled out, we suggest you try USG Brushes with Statite. Statite is a permanent shunt connection needing no hammerclips. It can't be jarred out even under severe operating conditions, and will assure your electric motors of steady, maintenance-free performance. In addition, Statite shunt connections, which eliminate troublesome rivets, retain their original low millivolt shunt drop, cannot oxidize, and are unaffected by temperature extremes. USG Brushes are manufactured in a variety of types and sizes for all applications from fractional horsepower to diesel generator. Grades available include carbon and carbon-graphite, electrographitic, graphite, metal graphite, and silver graphite.

THE UNITED STATES GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW 9, MICHIGAN

GRAPHITAR® CARBON-GRAPHITE • GRAMIX® SINTERED METAL PARTS • MEXICAN® GRAPHITE PRODUCTS • USG® BRUSHES

SEND THE ATTACHED COUPON . . .
for Engineering Handbook B-56 and Brush Grade Supplement.

231

THE UNITED STATES GRAPHITE COMPANY
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MEASUREMENT and CONTROL PROBLEMS?

Bring 'em to Taylor!

Simple problem or complex headache—if it has to do with instruments your Taylor Field Engineer is a good man to see. Taylor instruments are known throughout industry for their dependability, accuracy and ruggedness. Just as important, Taylor Engineers are highly trained, widely experienced in dealing with all kinds of application problems and always at your service.

Illustrated here are just two types of recording instruments and a simple industrial thermometer. The Taylor line includes transmitters, controllers and receivers (both indicating and recording) for a wide variety of applications. The trade name FULSCOPE* for example has become synonymous with quality and dependability in temperature, pressure and flow control. The TRANSET* line of miniature "plug-in" instruments is flexible, economical and ideal for use on graphic panels or small sized conventional panels. To find out how Taylor instruments can go to work for you, call your Taylor Field Engineer, or write for **Bulletin No. 98261.**

Taylor Instrument Companies, Rochester, N.Y., and Toronto, Canada.

No. 76JM Temperature Recorder. ACCURATUS* Mercury Actuated Thermal System gives an extremely high order of accuracy, because ACCURATUS tubing fully compensates for fluctuating temperatures along the connecting tubing between sensitive element and instrument case. This exclusive Taylor tubing also means that the instrument may be mounted 200 ft. or more from the point of measurement. Wide selection of standard charts, within limits of minus 40° and plus 1,000°F., or equivalent C.

BI-THERM* Bimetallic Dial Thermometer. Available with 3" or 5" dials and a complete range of stem lengths and temperature scales. All-welded stainless steel construction with hermetically sealed bezel. Silicone damping prevents pointer chatter and improves speed of response. Simple zero set adjustment. Unaffected by ambient temperature changes—accuracy well within 1%.

No. 76JF Pressure Recorder. For recording one, two or three Gage Pressures. Provides a permanent, legible and accurate record. Chart changing is a simple one-hand operation, because pen lifter is combined with chart locking device. Case of die-cast aluminum, designed for face or flush mounting. Highly resistant to vibration. All parts easily accessible for adjustment and interchangeable with other Taylor instruments.

Instruments for indicating, recording, and controlling temperature, pressure, flow, liquid level, speed, density, load and humidity.

*Trade Mark

Taylor Instruments
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ACCURACY FIRST

VISION · INGENUITY · DEPENDABILITY

nomena; magnetism and magnetic properties—the theoretical basis of magnetic phenomena, the physics of magnetic materials; semiconductors and dielectrics—the physics of semiconductors, semiconductor devices; non-crystalline materials—some aspects of the physics and chemistry of cement, molecular structure and mechanical behavior of high polymers, the physics of glass. Numerous formulas, line drawings, graphs and photographs are used throughout the book.

"Standard Shapes and Sizes of Grinding Wheels" (Simplified Practice Recommendation R45-57 (Supersedes R45-47)) has recently been issued by the Grinding Wheel Institute, 2130 Keith Building, Cleveland 15, Ohio. The book contains 76 pages, 8½ x 11 in., in paper cover, and is available free of charge for single copies. It was approved for promulgation by the United States Department of Commerce on July 1, 1957. The purpose of this recommendation is to eliminate avoidable waste through the establishment of standards of practice for shape types and sizes of grinding wheels that currently are in general production and demand. This revised recommendation was necessitated by the fact that many important changes in grinding practice have taken place since the 1947 revision. There was a need to add wheel sizes and shapes not listed in the former recommendation as well as delete some sizes formerly listed. The recommendation makes possible the selection of suitable wheels for most grinding needs, items not shown can still be procured when necessary to service existing equipment. Where new shapes have been added, care has been taken to list an adequate assortment of sizes for all practical needs without including any unnecessary items; other sizes can be supplied where necessary.

"Solvent Extraction in Analytical Chemistry," by George H. Morrison and Henry Freiser, has recently been published by John Wiley & Sons., Inc., 440 Fourth

(*Please turn to page 312*)

Protects Metals Against Hot Acids, Acid and Sulfurous Fumes, Salt Spray, Steam, Mild Alkalies, Up to 600° F.

Markal "D-A" Coatings will protect metal against any corrosive action. It is an ideal product for ore sintering plants, plating plants, food plants, lumber kilns, foundries, chemical plants, sewage disposal plants, laundries, heat exchangers. . .many others.

Markal "D-A" Coatings are applied by brush or spray and can be air dried or baked. The Coatings will withstand temperatures up to 600°F.

For free sample write on company letterhead, stating temperature extremes, surface temperature at time of application, and corrosive condition.

Other Markal Coatings are available in a complete range of types for any condition and temperatures up to 2200°F. Send for catalog No. MPC. The **Markal Company,** 3087 West Carroll Avenue, Chicago 12, Illinois, Telephone Sacramento 2-6085

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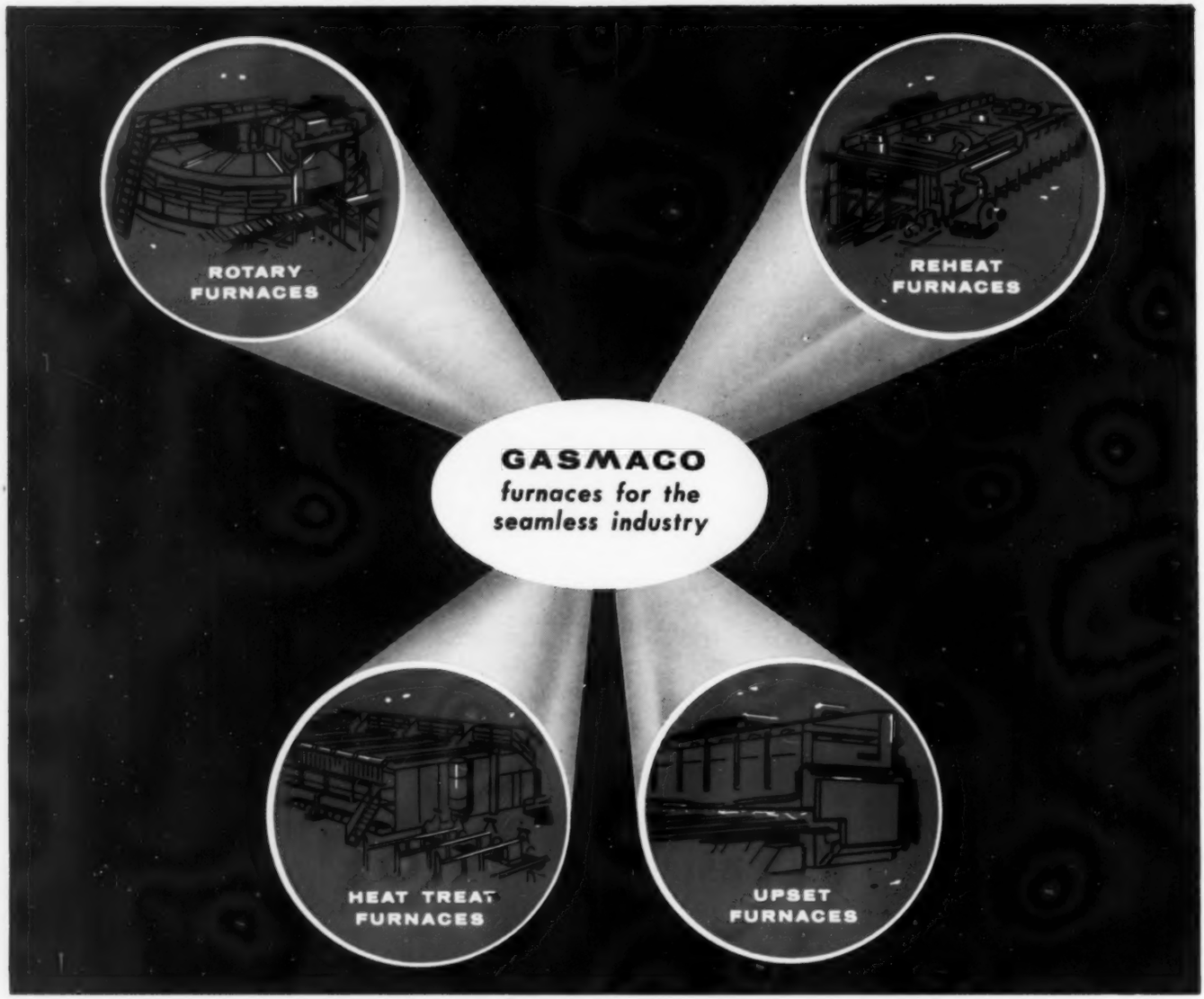


TUBE MILL FURNACES

GASMACO Furnaces are used in the Seamless Industry for all heating operations from billet heating to final tube heat treatment:

Rotary Hearth Furnaces up to 80′ for billet heating — Automatic Charging and Unloading.

Reheat Furnaces for plug mills or sizing.

Walking Beam Multi-Zone Furnaces for Hardening — Drawing — Normalizing . . . up to 100-Ton capacity.

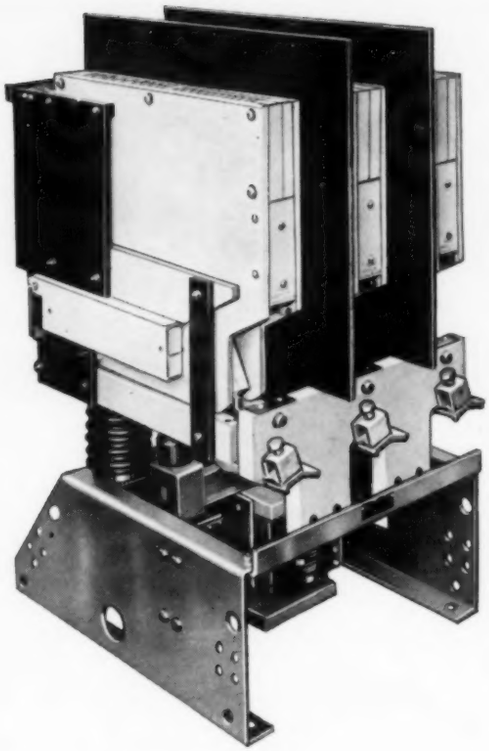
Slot Furnaces for upsetting — high head heating.

THE GAS MACHINERY COMPANY, INDUSTRIAL FURNACE DIVISION, 16128 Waterloo Road, Cleveland 10, Ohio. In Canada: The Gas Machinery Co. (Canada) Ltd., Hamilton, Ontario.

✔ *Check first with GASMACO for latest industrial furnace designs.*

THE **gas machinery** COMPANY

GAS PLANT EQUIPMENT
AND INDUSTRIAL FURNACES



The remarkable design simplicity of the Allen-Bradley high voltage contactors is the basic reason for their QUALITY performance. The one moving part principle (used in all Allen-Bradley low voltage magnetic contactors) plus double break, silver alloy contacts assure long, trouble free life and minimum maintenance inspection.

air break switches

MODERNIZE

high voltage starters

The new Allen-Bradley air break, high voltage contactor is the basic switching device in a comprehensive line of Allen-Bradley high tension starters for synchronous and squirrel cage motors . . . up to 3000 hp, 2501-4600 volts.

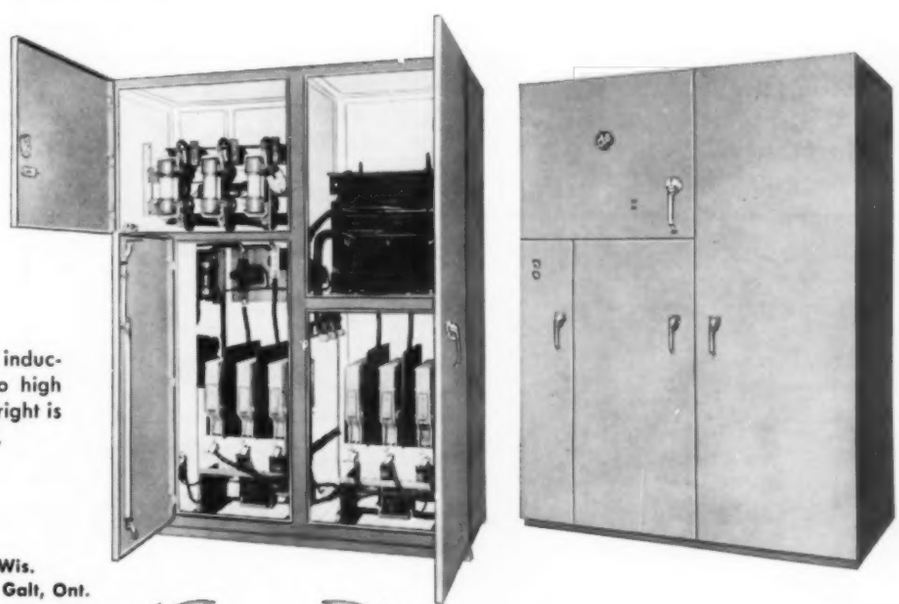
Allen-Bradley high voltage starters are available for full voltage or reduced voltage starting. All starters are equipped with current limiting fuses. They all have an interrupting capacity of 150,000 kva at 2300 volts and 250,000 kva at 4600 volts. For safety, the front operated disconnect switch is interlocked with the doors of the high voltage compartments and also with the high voltage contactor. Overload relays with current transformers provide continuously reliable overload protection.

The simple design . . . with ONLY ONE MOVING PART . . . and the double break, silver alloy contacts which are always in good operating condition . . . have set a new standard for maintenance free, high voltage motor control.

Send for the Allen-Bradley Bulletin 6080 describing the complete Allen-Bradley high voltage line.

A-B QUALITY

The Sign of
QUALITY
Motor Control



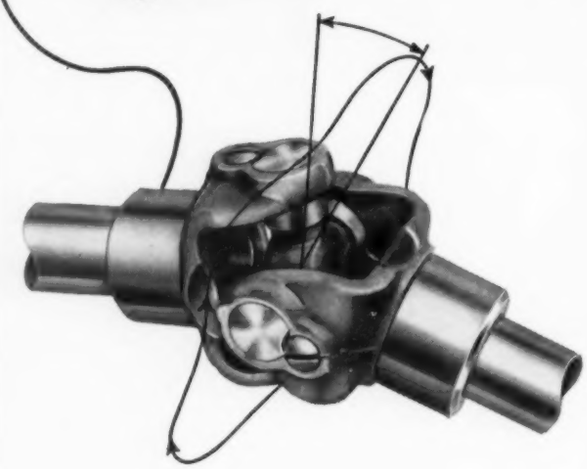
Bulletin 1172 reduced voltage induction motor starter with doors to high voltage compartments open. At right is the starter with all doors closed.

Allen-Bradley Co.
1343 S. First St., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

ALLEN-BRADLEY SOLENOID MOTOR CONTROL

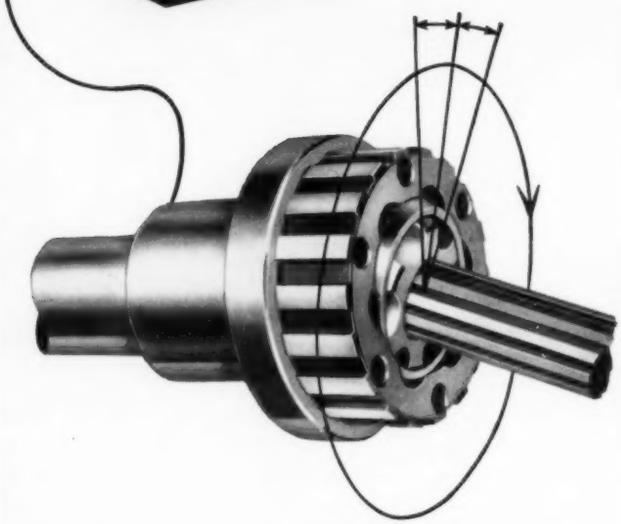
QUALITY

THIS ACTION MAY HAVE A LOWER PRICE



Old-fashioned pin or slipper-type joints speed up, slow down twice during one revolution. This delivers rough "rock and roll" torque which results in greater vibration and wear. They must employ clumsy additional mechanisms to compensate for their unbalanced action at extreme angles.*

THIS ACTION ALWAYS HAS A LOWER COST



Rzeppa Joints *always* transmit smooth "full power" torque at angles as much as 35°! Ball bearings—located in a plane bisecting the angle between driving and driven members—deliver smooth rotation, eliminating wear and vibration. Constant velocity means longer joint and shaft life, too.*

57A

RZEPPA

SHEPPA

CONSTANT VELOCITY UNIVERSAL JOINTS

The Gear Grinding Machine Company

3929 CHRISTOPHER, DETROIT 11, MICHIGAN

MANUFACTURERS OF: FULLY AUTOMATIC GEAR GRINDING MACHINES
DETROIT SCREWMATIC 750 SINGLE SPINDLE SCREW MACHINES

*HOW RZEPPA'S CONSTANT VELOCITY SAVES YOU MONEY. If a universal joint operates with less friction it wears longer; if it has a higher capacity it can produce more. Through the principle of constant velocity—shown above—Rzeppa delivers these cost-savings that are impossible with designs of lower price.

Send us a dimensional sketch along with peak horsepower, operating angles and R.P.Ms. Our engineers will assist in making a proper joint recommendation. WRITE FOR LATEST BROCHURE.

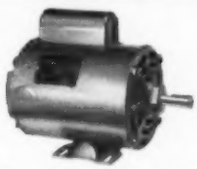
WAGNER ELECTRIC MOTORS...THE CHOICE OF LEADERS IN INDUSTRY

Reduce Down Time—Power your Equipment with *Dependable* Wagner Motors

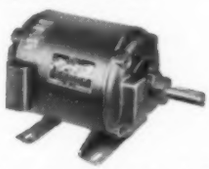
Sixty-six years of experience goes into the building of Wagner Motors. Their reputation for reliability, their electrical characteristics, price and prompt delivery make them a sound choice for your equipment.

Whatever your motor requirements may be—single-phase or polyphase... ⅙ or 500 horsepower—Wagner can offer a standard motor that is entirely dependable in its specific application. A few of the many motors in the Wagner line are shown below.

FRACTIONAL HP



TYPE RK — Capacitor-start Induction. For general purpose applications. Single-phase. Rigid or resilient mounting. 48 frame: ⅙ or ¼ hp. 56 frame: ⅓ through ¾ hp. Also available in integral ratings through 5 hp.



TYPE RA — Repulsion-start Induction. For general purpose applications. Single-phase. High starting torque—low starting current. ⅙ through ¾ hp. Also available in integral ratings through 15 hp.

TYPE RB — Split-phase Induction. For easy starting applications. Single-phase, resilient mounting. 48 frame: ⅙, ¼ or ⅓ hp.

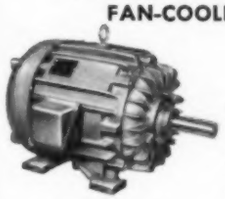
TYPE RP — Polyphase Squirrel-cage Induction. General purpose, normal torque. 56 frame: ¼ through ¾ hp.

INTEGRAL HP

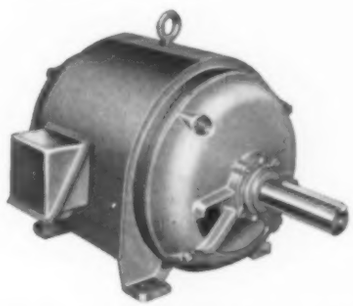
DRIP-PROOF

TYPE DP—Squirrel-cage Induction, corrosion resistant cast iron frames. 1 through 125 horsepower.

TOTALLY ENCLOSED FAN-COOLED



TYPES EP AND JP
Standard and explosion-proof. Squirrel-cage Induction, corrosion resistant cast iron ribbed frames, 1 through 30 hp—smooth frames, 40 through 250 hp.



OPEN TYPE POLYPHASE SQUIRREL CAGE

TYPE RP—Drip-proof. Suitable for all general purpose applications. Available in ratings 150 through 500 hp.

OTHER WAGNER MOTORS

In addition to a complete line of standard motors, Wagner also furnishes Increment Type Motor and Starter Combinations... Wound Rotor Polyphase Motors... Jet Pump Motors... Vertical and Flange Mounted Motors... Hermetic Motors... Gear Motors and Direct-Current Motors. Consult the nearest of our 32 branch offices, or mail coupon today for full information on the complete Wagner line.

Wagner Electric Corporation
SERVING INDUSTRY SINCE 1891

M57-10A

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6483 Plymouth Ave., St. Louis 14, Mo.
Please send Bulletin MU-185 on your complete line of Motors.

NAME_____
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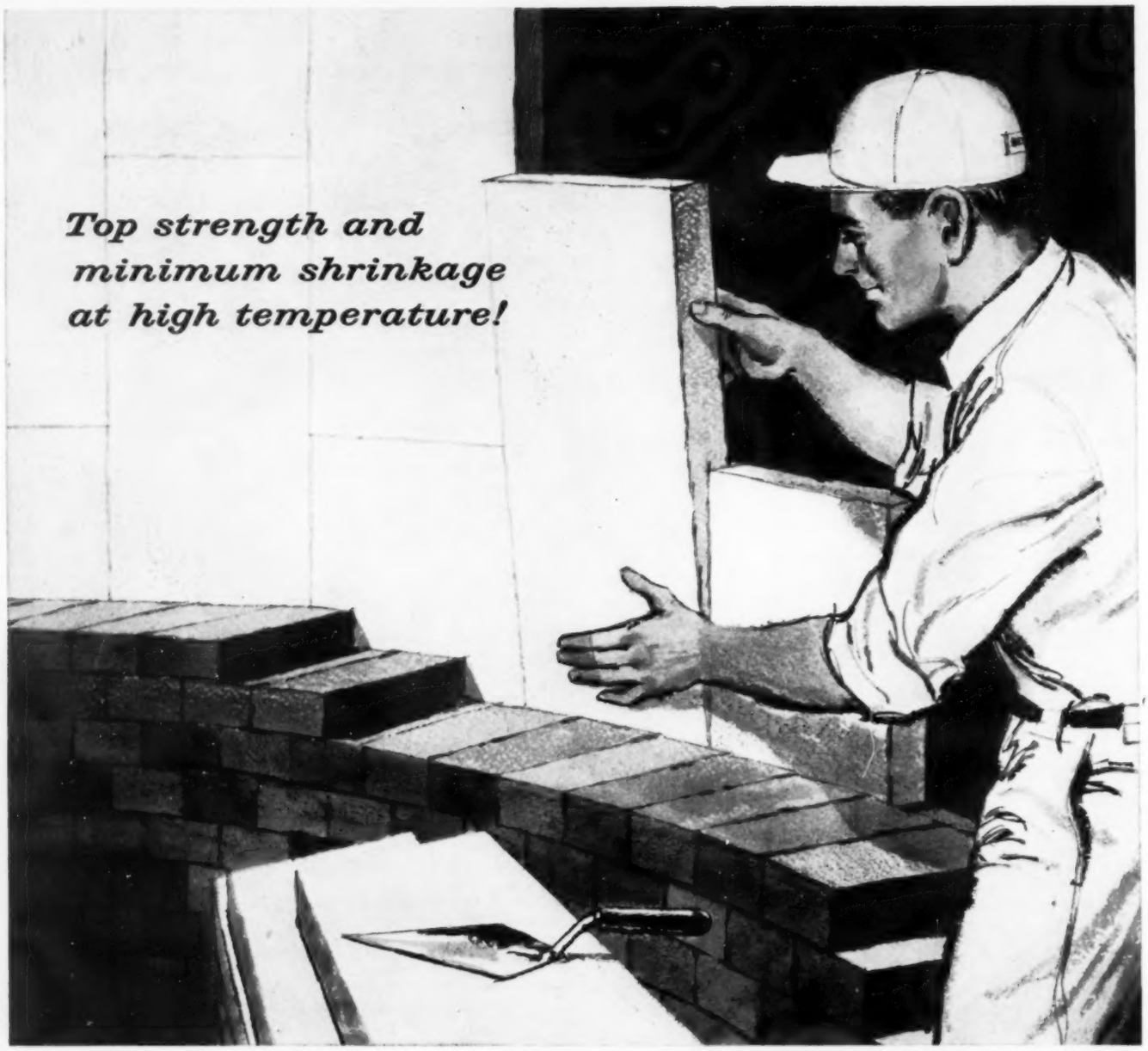
ADDRESS_____
CITY & STATE_____



Superex is easily combined with other insulations such as Johns-Manville Thermobestos®, J-M 85% Magnesia or J-M Insulating Fire Brick.

After a quarter century . . .

there's still no substitute for J-M Superex insulation for service to 1900F!

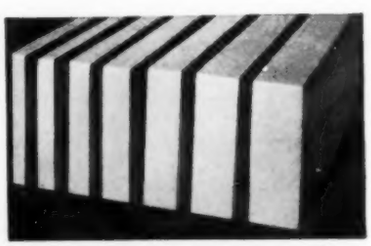
In many ways, Superex® is the finest block insulation yet developed for high temperature furnace applications!

Made of diatomaceous silica and asbestos, Superex offers exceptional heat resistance—excellent insulating value. And at high temperature its stability is unsurpassed: it combines low shrinkage with excellent thermal effectiveness . . . easily withstands the physical abuse encountered in normal service.

Superex also speeds and simplifies installation. *Easy-to-handle*—Superex weighs only 2 lbs. per sq. ft. per inch thickness. *Strong*—it compresses only ⅛ inch under 6 tons' pressure per square ft. Superex is available in a wide variety of shapes and sizes . . . is easily cut with an ordinary knife or saw.

For further information write to Johns-Manville, Box 14, New York 16, N. Y. In Canada, Port Credit, Ontario.

For medium temperature applications, specify J-M Superex M blocks . . . for temperatures to 1600F.



Saves waste. Superex comes in 7 standard thicknesses from 1" to 4". Other sizes available on order.

Johns-Manville INSULATIONS *FOR LASTING THERMAL EFFICIENCY*

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F·E·I DIRECT FIRING SYSTEMS

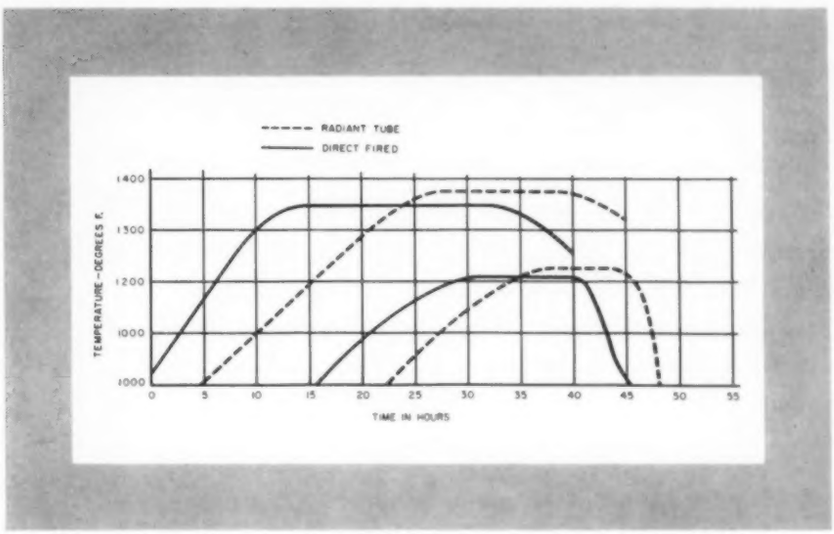
Cut Production Costs . . . .

Produce up to 50% more tons per hour

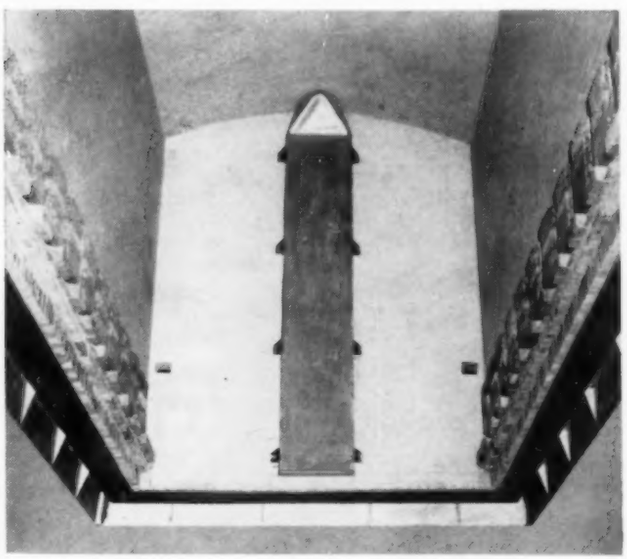
■ Direct fired cover type annealing furnaces—new or converted—consistently out-produce radiant tube type furnaces. The chart at right shows how direct firing assures faster heat-up and quicker cooling that greatly increase production rates and reduce production costs!

But higher production is not the only advantage—greater fuel economy, reduced downtime for repairs and elimination of costly alloy radiant tube replacement help reduce production costs even further.

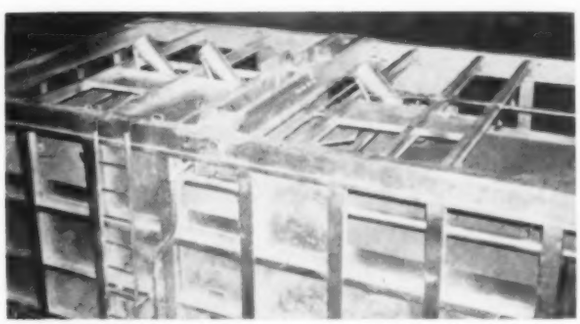
To get full details on F.E.I. direct firing for new furnaces or for converting existing settings contact F.E.I.



This chart shows what happens inside a cover type annealing furnace operating under direct firing compared with radiant tube firing. Both types of furnaces were operated under identical conditions. The upper lines represent the furnace temperature, while the lower lines show actual steel control temperatures.



The flue and burner arrangement inside a direct fired furnace that is equipped with F.E.I. burner system.



The patented F.E.I. eductors on top the furnace assure complete combustion, uniformity of temperature, and consistent flue gas analysis for longer inner cover life.

F.E.I. Under New Management

Furnace Engineers is now under the management of Mr. A. A. Straub and his associates. Financial management and sales policies have been modernized in line with present day business demands.

Furnace Engineers, Inc.

212 BOULEVARD OF THE ALLIES • PITTSBURGH 16, PA.

Send For This Bulletin—Describes all types of F.E.I. heat treating furnaces.

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CHEMICALS, PRIMARY METALS, MACHINERY?

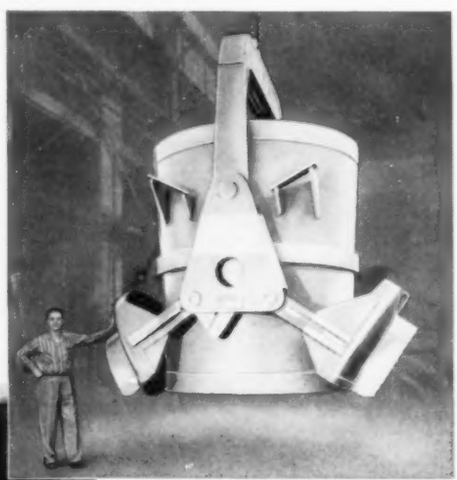
Special indexing machine tool base over ten feet in diameter, weight nearly ten tons.

You name it—and the odds are two to one that McGregor-Michigan is experienced in *your* line. We're turning out an endless miscellany of steel plate fabrications for industries across the nation. As part of the proof of our ability and versatility, here are a few of the products of the manufacturers and processors we're serving:

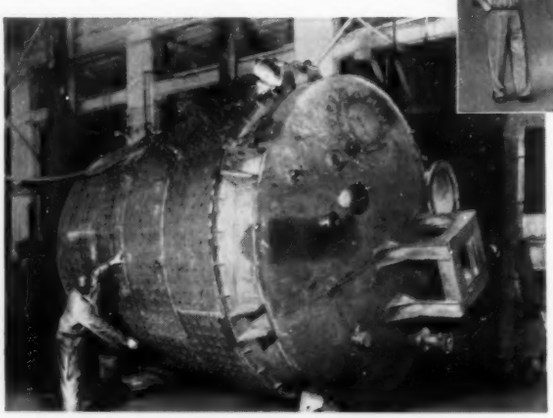
> Acids, alkalis, fertilizers, glass, refractories, plastics, petroleum, steel, aluminum, automation and special machinery, explosives, paper, diesels, cement and rock products, coke by-products, leather, soap, tools and dies, textiles—and numerous variations of these.

As further evidence of the reliability of McGregor-Michigan, we're proud to point out that the frequent repeat orders from these fine customers are the surest indication that we've earned their good will. How? By seeing that all factors are in balance: price, quality, delivery and service—for it is only by complete attention to *all* of these that we are able to fully satisfy our many diversified customers.

If you don't see your particular industry included in the list above, think of the many problems these customers have thrown at McGregor-Michigan —then go and do thou likewise.

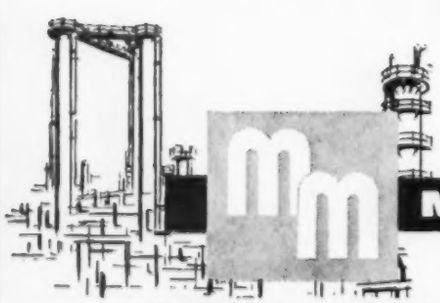


Steel mill scrap bucket. Linkage equalizes opening of clamshell halves.



Stainless steel jacketed chemical mixing kettle. Operates under vacuum and atmospheric pressure, medium high temperatures.

Send for new booklet showing equipment and typical steel plate fabrications.



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For application to soaking pits, heating, and other types of metallurgical furnaces.
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USE THE ENGINEERING MART

(*Continued from page 303*)

Avenue, New York 16, N. Y. This book offers comprehensive coverage of the theory and practice of solvent extraction methods. The first part, devoted to principles, offers a systematic classification of extractions; the second section is concerned with the practical aspects, including apparatus and techniques. The contents is in four parts: Part 1 contains principles of solvent extraction and deals with the classification of metal extraction systems, discusses phase rule, distribution law, thermodynamic derivation of distribution law, distribution ratio, percentage and process of extraction, formation of metal complexes, distribution of the extractable species; chemical interactions in the organic phase, quantitative treatment of extraction equilibria and kinetic factors in extraction. Part 2 handles apparatus and general techniques which includes methods of extraction, techniques in extraction and completion of analysis. Part 3 presents extraction systems under topics such as ion association systems and chelate systems. Part 4 deals with separations and contains selected procedures for the extraction of the elements. Formulas, line drawings, equations and numerous tables illustrate and substantiate the text.

"Metallurgical Progress-3" has recently been published by the Philosophical Library Inc., 15 East 40th St., New York 16, N. Y. The book contains 88 pages, 8½ x 11 in., is cloth bound, and sells for $6.00. This is the third series of critical reviews by leading specialists to present a survey of the present state of knowledge on such branches of the iron and steel industry as refractories, non-destructive testing, coke and foundry technology. Each of these new reviews comprises a compilation and analysis of published information which would represent a great deal of research for students in these fields. There are seven reviews contained in the volume: refractories in the iron and steel industry which deals with alumino-silicates, alumino silicates —corrosion resistance, refractories in the blast furnace, and other applications; non-destructive testing, discussed under surface condition, ultrasonic testing, and radiography; metallurgical coke 1939–55; foundry sand practice; reducing the phosphorus content of foundry iron; iron foundry metal melting furnaces; and mechanical properties of flake graphite cast irons.

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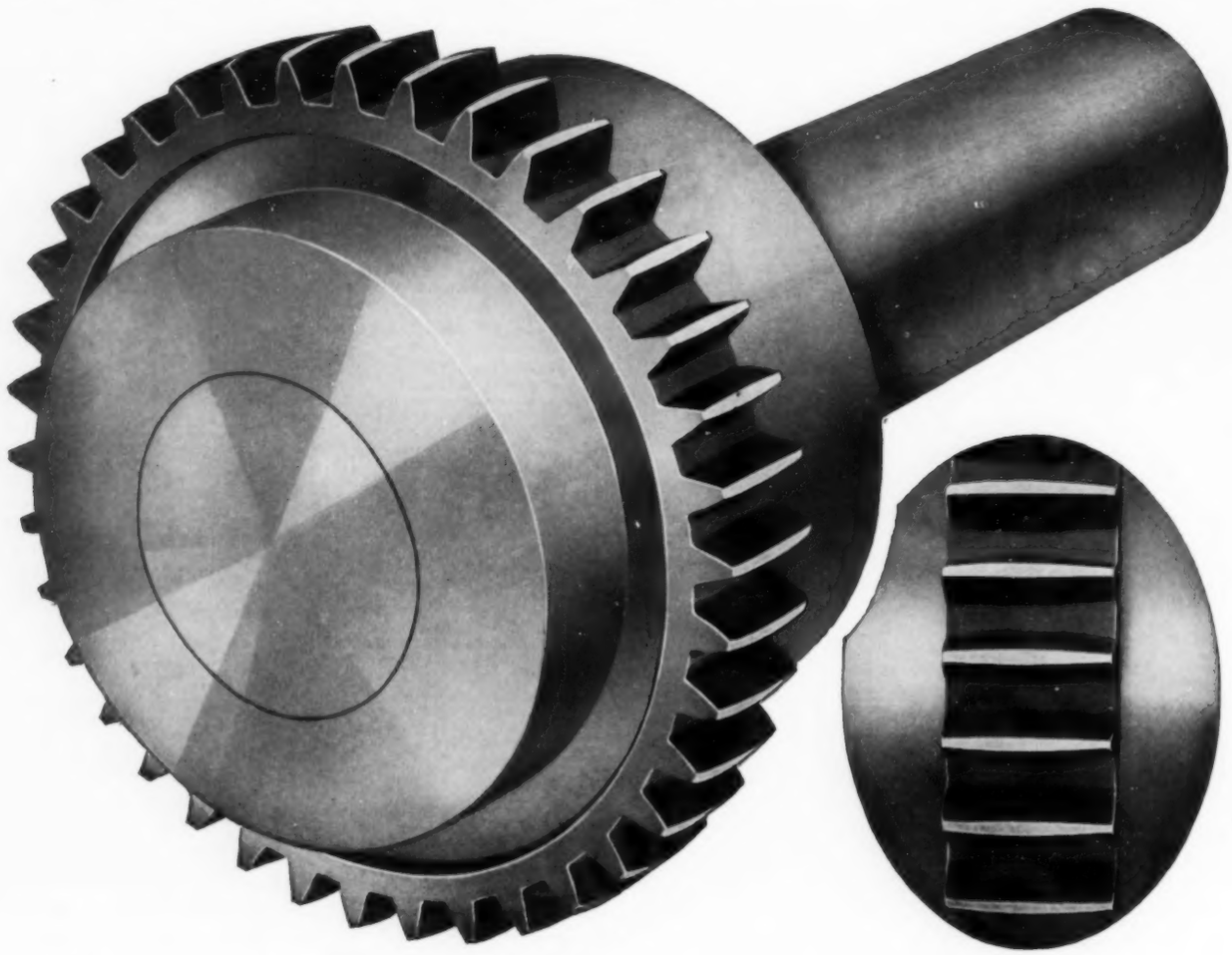

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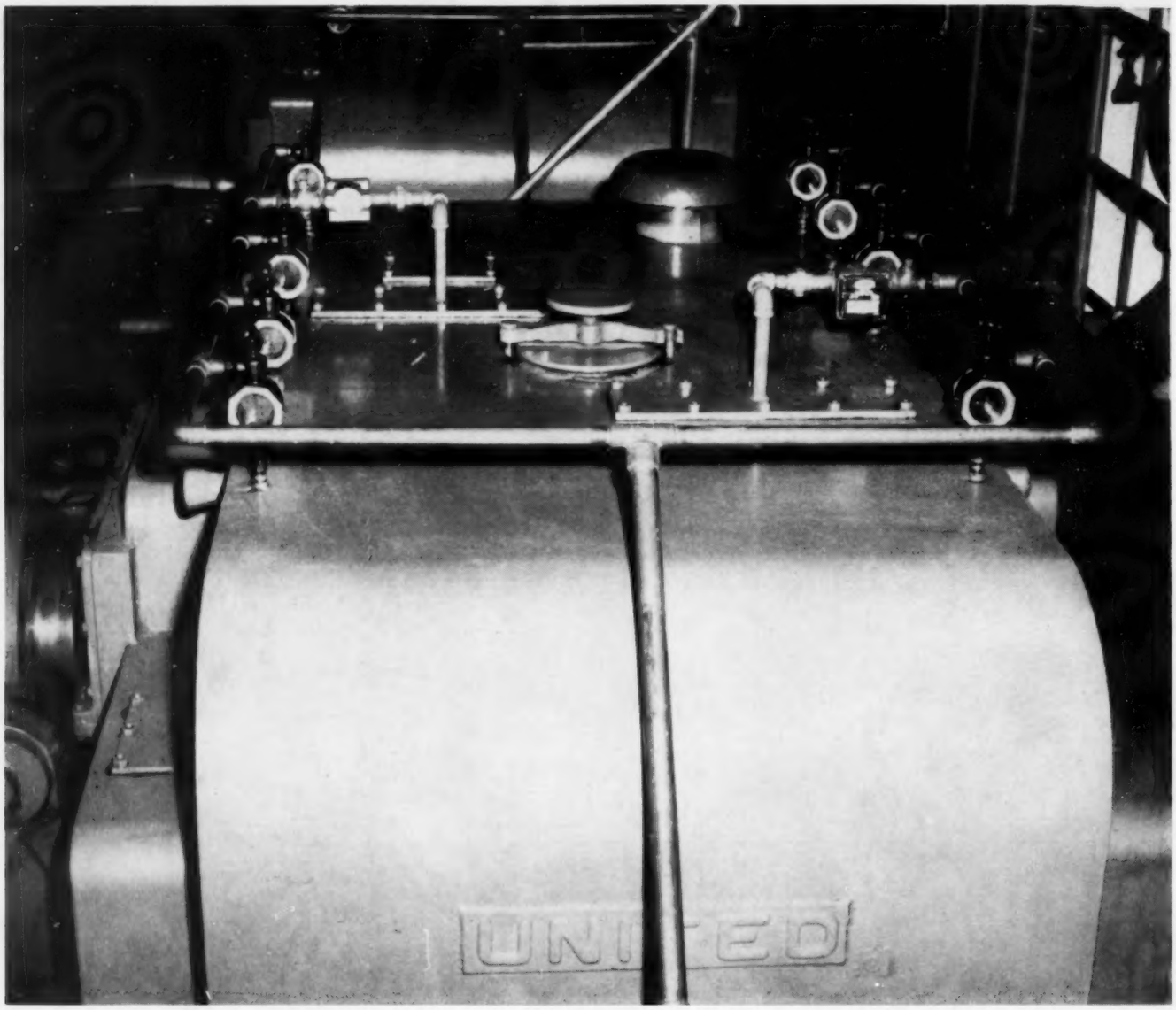

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